Assessment of Dam Safety
Coal Combustion Surface Impoundments (Task 3)
Final Report

Duke Energy
Buck Steam Station

Spencer, North Carolina

Prepared for

Lockheed Martin

2890 Woodridge Ave #209
Edison, New Jersey 08837

September 14, 2009

CHA Project No. 20085.5000.1510

CHA

I acknowledge that the management units referenced herein:

- New Dike
- Main Dike
- Diverter Dike
- Basin 1 to Basin 2 Outlet Dam
- Basin 2 to Basin 3 Outlet Dam

Have been assessed on June 9, 2009 and June 10, 2009.

Signature: Malcolm D Hargraves

Malcolm D. Hargraves, P.E.
Senior Geotechnical Engineer
Registered in the State of North Carolina

Signature: Kath E Adnams

Katherine E. Adnams, P.E.
Senior Geotechnical Engineer

Reviewer:

John P. Sobiech, P.E.
Partner

NORTH CAROLINA PROFESSIONAL SEAL 028061 ENGINEER JOHN P. SOBIECH, P.E.

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLES

FIGURES

FIGURES - CONTINUED

APPENDIX

1.0 INTRODUCTION & PROJECT DESCRIPTION

1.1 Introduction

CHA was contracted by Lockheed Martin (a contractor to the United State Environmental Protection Agency) to perform site assessments of selected coal combustion surface impoundments (Project #0-381 Coal Combustion Surface Impoundments/Dam Safety Inspections). As part of this contract, CHA was assigned to perform a site assessment of Duke Energy's Buck Steam Station, which is located in Spencer, North Carolina as shown on Figure 1 – Project Location Map.

CHA made a site visit on June 9, 2009 and June 10, 2009 to inventory coal combustion surface impoundments at the facility, to perform visual observations of the containment dikes, and to collect relevant information regarding the site assessment.

CHA Engineers Malcolm Hargraves, P.E. and Katherine Adnams, P.E. were accompanied by the following individuals:

Company or Organization	**Name and Title**
US EPA	Randy Jackson
Duke Energy	Steve Townsend, General Manager
Duke Energy	Bill Wilson, Safety Orientation/Vendor Contract Coordinator
Duke Energy	Nob Zalme, Environmental Coordinator
Duke Energy	Kreig Leuschner, Production Manager
Duke Energy	Allan Stowe, Environmental Water & Waste Compliance
Duke Energy	Brent File, Technical Resources
Duke Energy	Tim Wilson, Procedures & Dike Equipment Owner
Duke Energy	Henry Taylor, Program Engineer
North Carolina EPD	Larry Frost

1.2 Project Background

The new dike and main dike at the Buck Steam Station are under the jurisdiction of the North Carolina Utilities Commission (NCUC). These impoundments are classified by the NCUC as high hazard (Class C) under North Carolina Dam Safety rules because of potential environmental damage in the event of a failure, not the potential for loss of human life. These impoundments are listed on the National Inventory of Dams (NID) with the following identification numbers:

Impoundment	NID ID	North Carolina ID
Basin 1 (New Dike)	Not Identified	Not Identified
Basins 2 and 3 (Main Dike)	NC01549	ROWAN-047

The EPA Coal Combustion Dam Inspection Checklist Forms provided in Appendix A note these impoundments has having a Significant Hazard Potential based on the National Inventory of Dams Criteria.

1.2.1 State Issued Permits

North Carolina State Permit No. NC0004774 has been issued to Duke Energy authorizing discharge under the National Pollutant Discharge Elimination System (NPDES) to the Yadkin River in accordance with effluent limitations, monitoring requirements and other conditions set forth in the permit. The permit became effective on August 1, 2008 and will expire on August 31, 2011.

1.3 Site Description and Location

Figures 2A and 2B shows the three management units constructed for the Buck Steam Station. There are two primary dikes containing the coal combustion waste (CCW) at the Buck Steam Station Site. One was constructed in 1956 and the other was constructed in 1982. Because of changes in where the ash sluice lines discharged over the years, these ponds and dikes have been referred to by different names. Table 1 lists the terminology we use in this report as compared to terminology noted in other documentation since the site's original construction.

Table 1 – Management Units Terminology

Terminology Used in this Report	Terminology Used on Past Documents (Reports, Plans, etc.)
New Dike	New Ash Dike or Additional Primary (New) Dike
Main Dike	Buck Ash Pond Dam
Basin 1	New Primary Pond or Additional Primary Cell
Basin 2	Old Primary Pond (Cell) or Primary Pond
Basin 3	Secondary Pond (Cell)

The diverter dike was constructed in 1977 to create two basins (Basins 2 and 3) out of the original ash pond to enhance sedimentation of the ash prior to discharge into the Yadkin River.

Basin 1 is located to the south of the Buck Steam Station. It is contained by natural ground on the east, south and southern half of the western side of the pond. The northern half of the western side and the north side are contained by the new dike. The new dike is about 2,070 feet long and about 72 feet high. Figure 3 shows a cross section of the new dike.

Basins 2 and 3 are located to the east, southeast of the Buck Steam Station. The main dike contains the north side of Basins 2 and 3. The remaining sides of these basins are contained by natural ground. The diverter dike separates Basin 2 from Basin 3. The main dike is about 1,900 feet long and about 70 feet high. The crest of the main dike varies and is at about El. 691 adjacent to Basin 2 and about El. 682 adjacent to Basin 3. Figure 4 shows a cross section of the main dike and Figure 5 shows a cross section of the diverter dike.

Two outlet dams were constructed in channels excavated in natural ground to control flows between Basins 1 and 2, and between Basins 2 and 3.

A map of the region indicating the location of the main and new dikes and identifying schools, hospitals, or other critical infrastructure located within approximately 5 miles down gradient of the ash ponds is provided as Figure 6.

1.3.1 Other Impoundments

No other impoundments were identified at the Buck Steam Station.

1.4 Previously Identified Safety Issues

Based on our review of the information provided to CHA and as reported by Duke Energy, there have been no identified safety issues at Basins 1, 2 and 3 in the last 10 years.

1.5 Site Geology

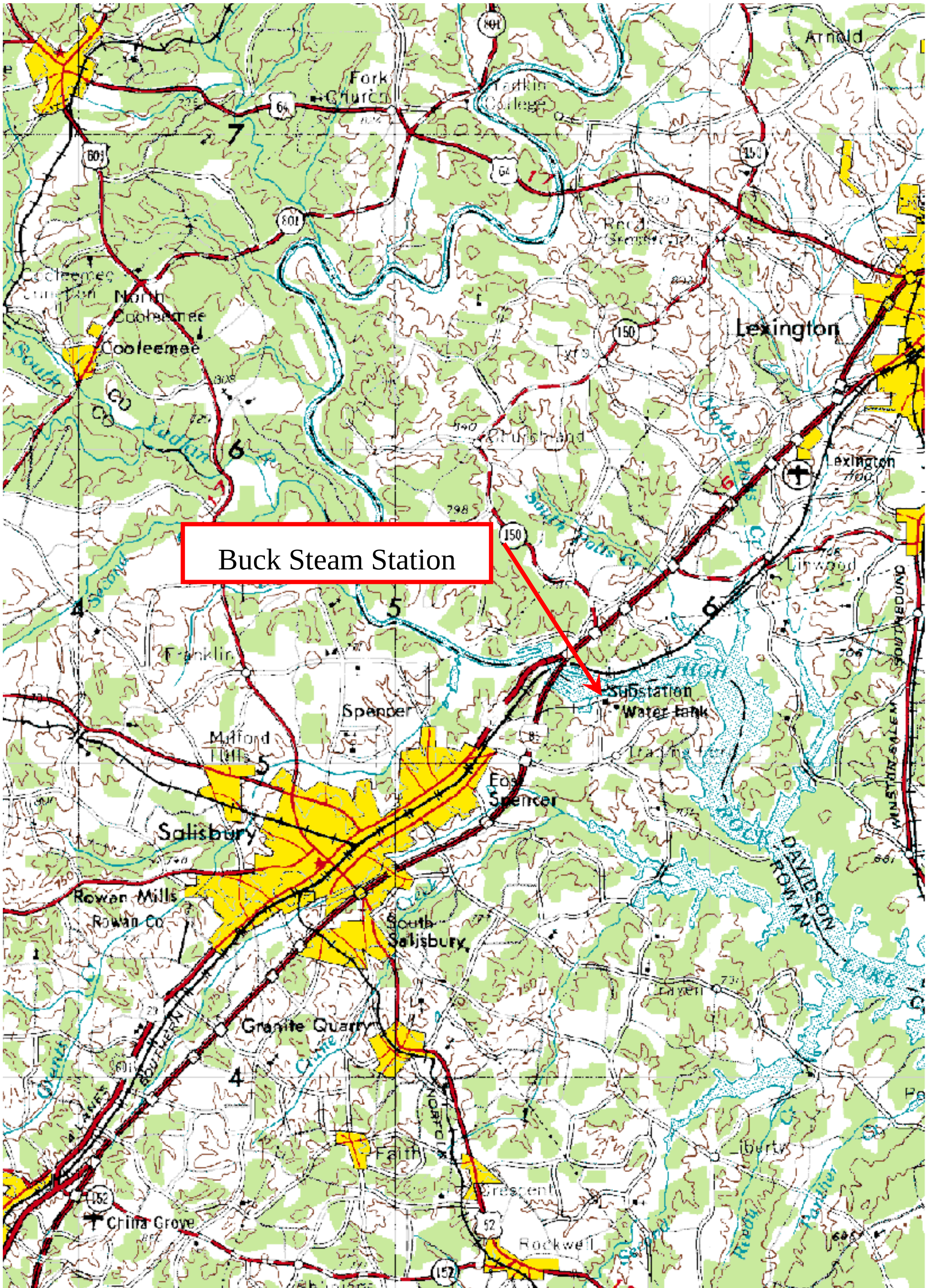
Based on a review of available surficial and bedrock geology maps, and reports by others, the site is located in an area where the surficial soil has resulted from a residually weathered Triassic to Cambrian rock such as porphyritic granite, alaskitic granite, quartz rich granite and gabbro. The surficial material is generally a silty clayey loam with variable coloring.

1.6 Bibliography

CHA reviewed the following documents provided by Duke Energy in preparing this report:

- *2008 Annual Ash Basin Dike Inspection Report*, October 17, 2008, S&ME, Inc.
- *Buck Steam Station Ash Dike Slope Stability Analysis*, December 2004, Devine Tarbell & Associates, Inc.
- *Sixth Independent Consultant Inspection Report Ash Basin Dikes Buck Steam Station*, February 28, 2006, Mactec Engineering and Consulting, Inc.

- Duke Energy Calculation Number BC-0238 – Ash Basin ¾ PMP Flood Routing, August 30, 1985
- Buck Landfill Preliminary Engineering Study Appendices C through F, January 23, 2009, S&ME, Inc.
- Selected Drawings B-3039-D, D-1, D-2, E, F and G, 1956 (with Revision Dates noted on drawings), Duke Power Company
- Selected Drawings B-3066 and B-3066-A through D, 1982 (with Revision Dates noted on drawings), Duke Power Company
- Selected Drawings B-2184-B and B-2184-B-1, 1979 (with Revision Dates noted on drawings), Duke Power Company
- Letter from Duke Energy Corporation to US EPA (with appendices), March 25, 2009



N

		Figure 1 **Project Location Map**
Scale: 1" = 2 miles	**Project No.:** **20085.5000.1510**	**Duke Energy** **Buck Steam Station** **Spencer, North Carolina**

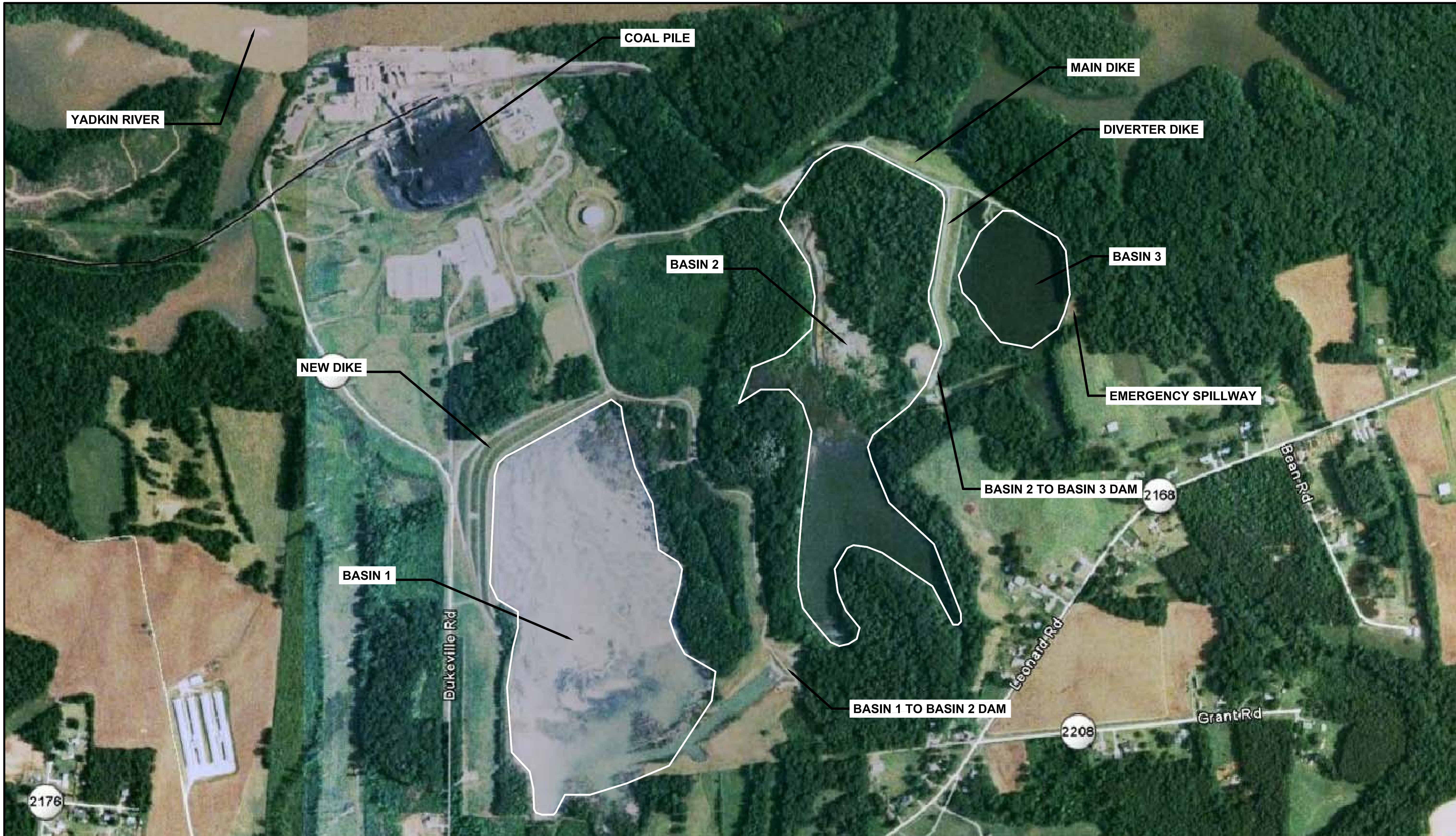


IMAGE REFERENCE: GOOGLE EARTH, IMAGE DATED JULY 2006.

0 600 1200
Scale in feet

Drawing Copyright © 2007 CHA

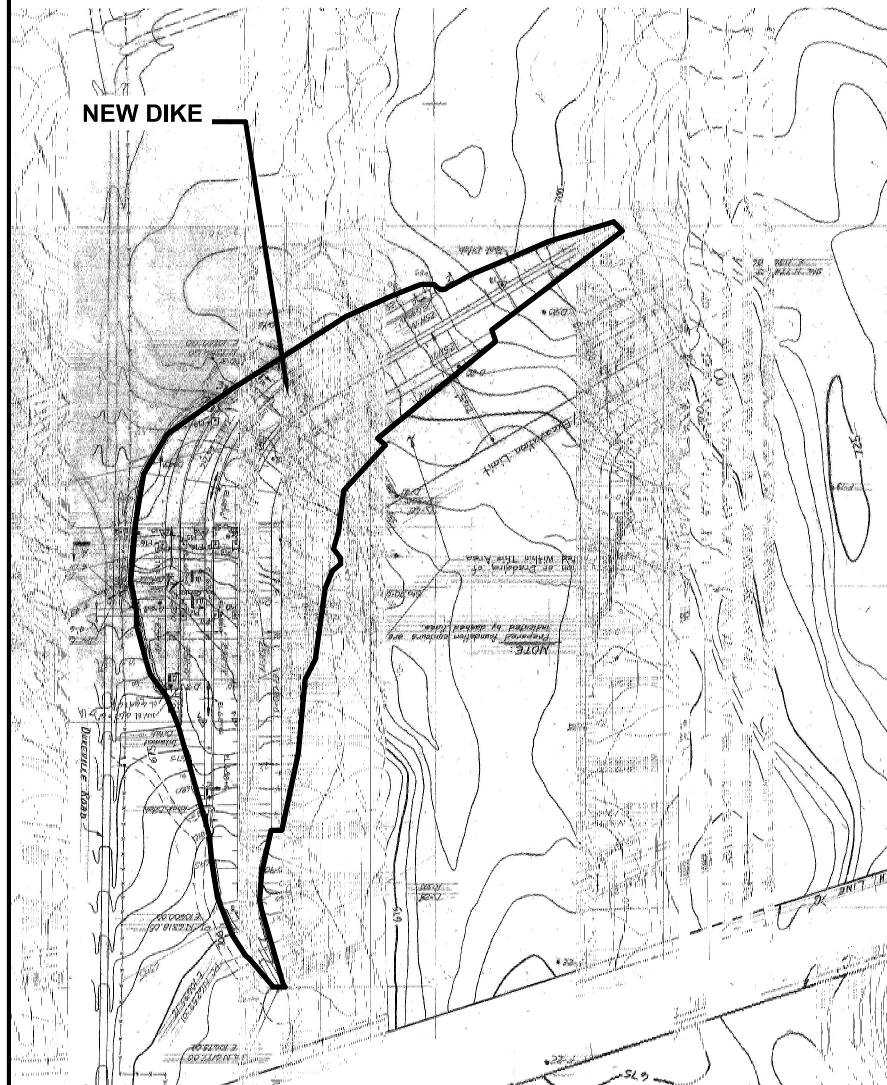
CHA

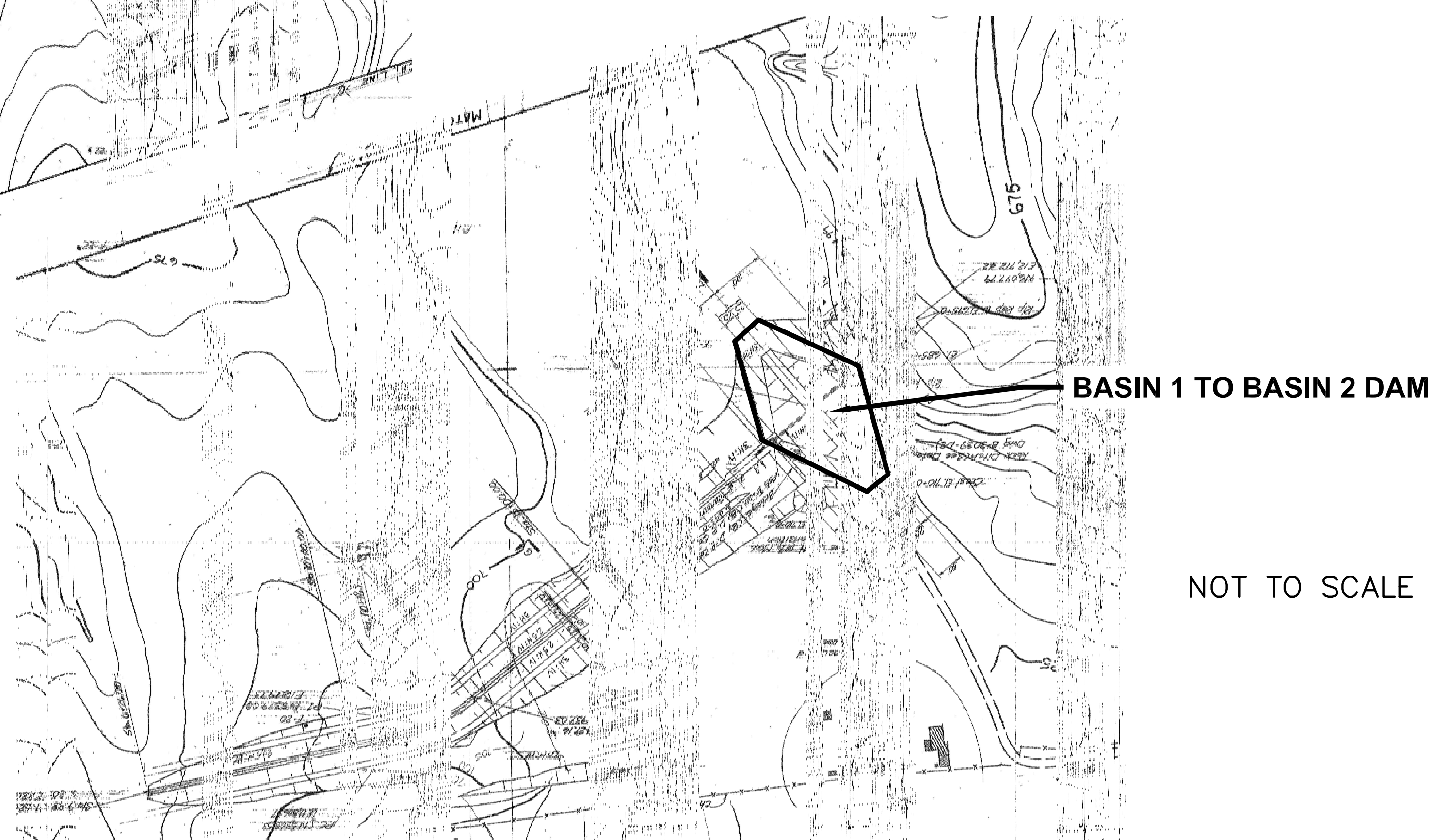
PHOTO SITE PLAN
BUCK STEAM STATION
DUKE ENERGY
SPENCER, NORTH CAROLINA

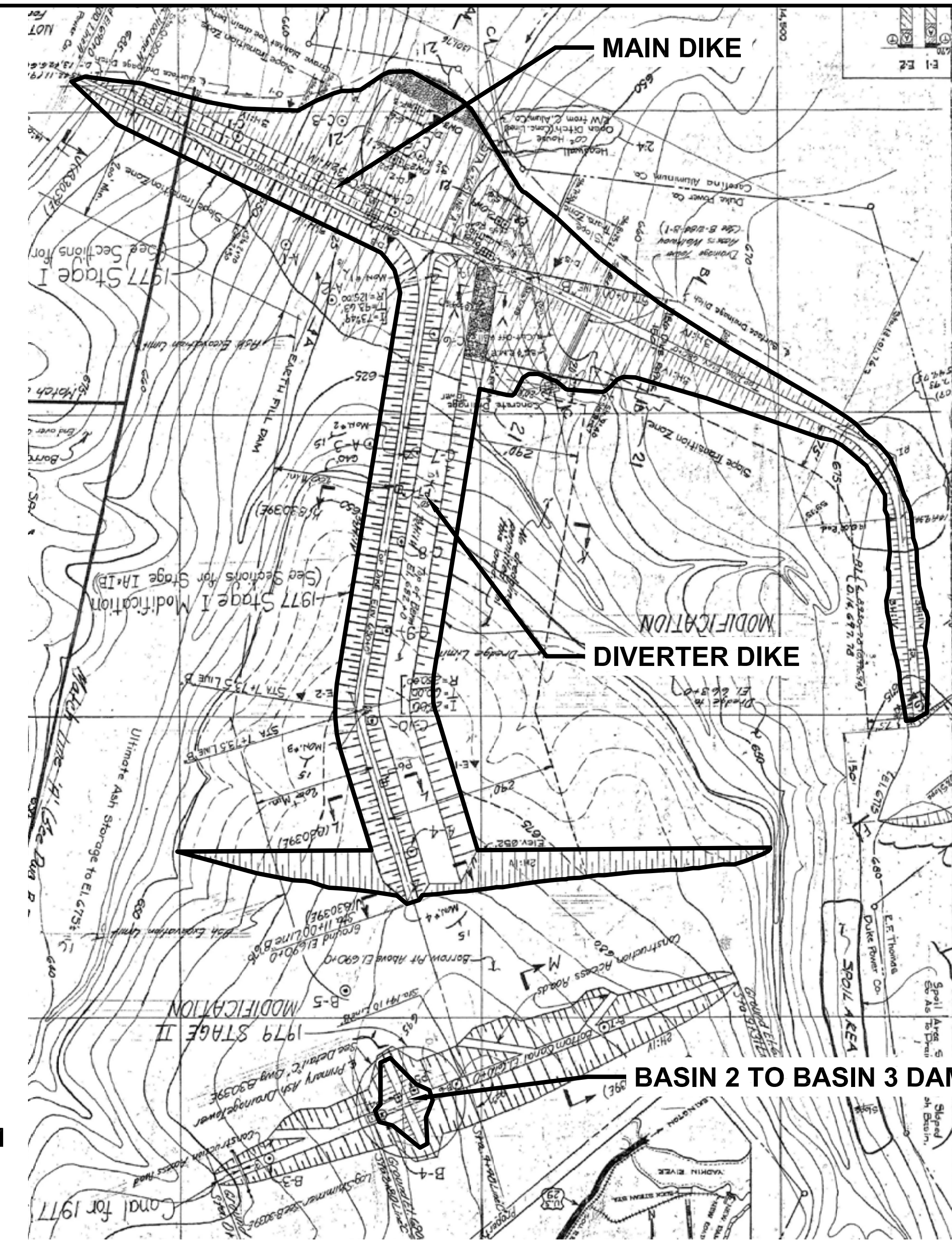
PROJECT NO. 20085.5000

DATE: JULY 2009

FIGURE 2A







NOT TO SCALE

IMAGE REFERENCES: 1956 B-3039-D NEW ASH, 1982 B-3039-D1 ASH STORAGE, 1982 B-3039-D2 ASH STORAGE

N

CHA

SITE PLAN OF DIKES
BUCK STEAM STATION
DUKE ENERGY
SPENCER, NORTH CAROLINA

PROJECT NO. 20085.5000

DATE: JULY 2009

FIGURE 2B

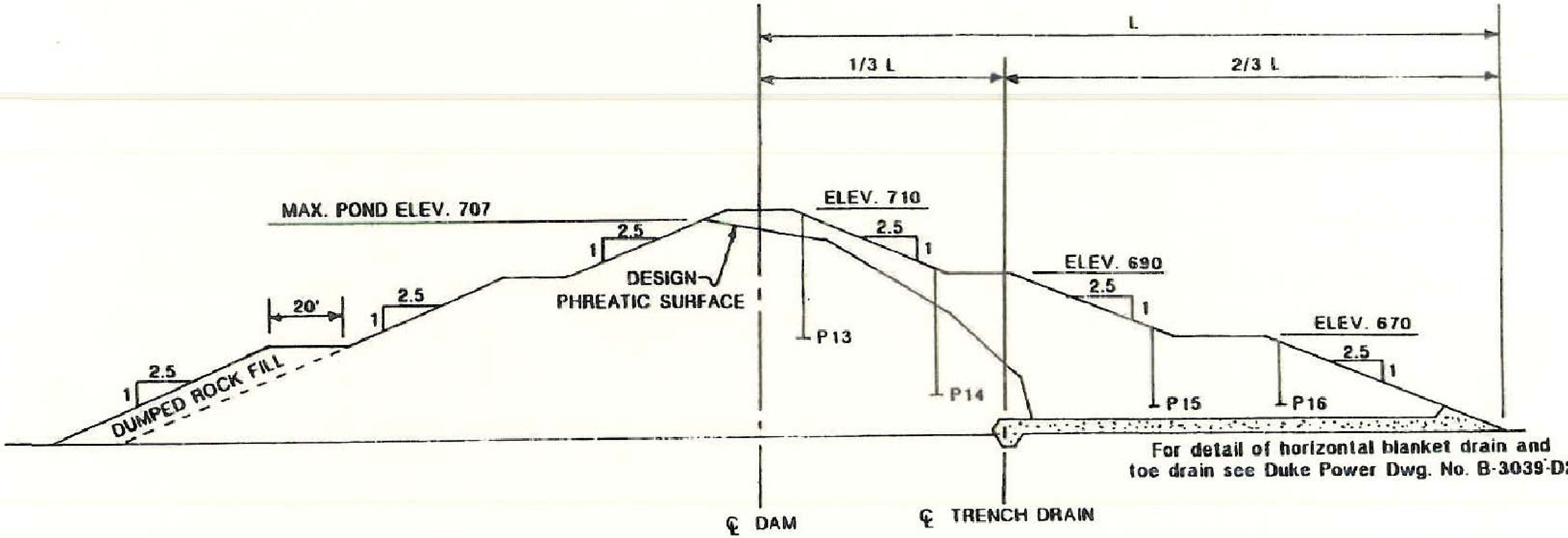


IMAGE REFERENCE: 6234-05-3350 BUCK STEAM STA., FIGURE 4

CHA

CROSS SECTION OF NEW DIKE
BUCK STEAM STATION
DUKE ENERGY
SPENCER, NORTH CAROLINA

PROJECT NO. 20085.5000

DATE: JULY 2009

FIGURE 3

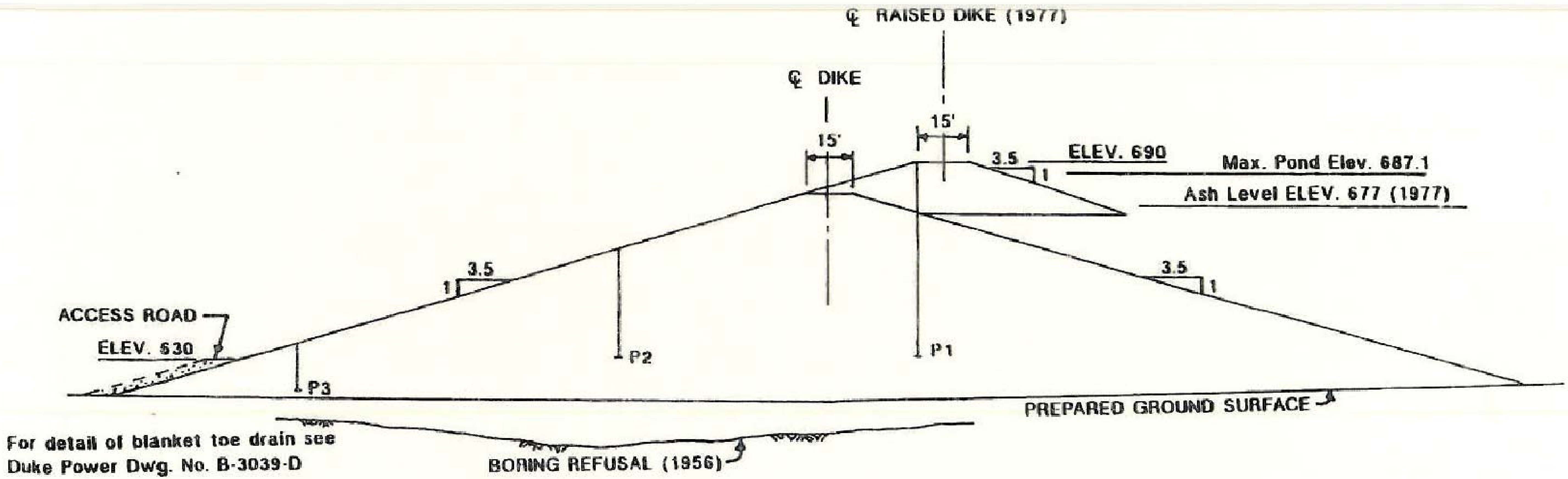


IMAGE REFERENCE: 6234-05-3350 BUCK STEAM STA., FIGURE 5

Drawing Copyright © 2007 CHA

CHA

CROSS SECTION OF MAIN DIKE
BUCK STEAM STATION
DUKE ENERGY
SPENCER, NORTH CAROLINA

PROJECT NO. 20085.5000

DATE: JULY 2009

FIGURE 4

File: K:\20085\CADD\ACAD\FIGURES\GEO\5000 BUCK\5000 BUCK XSECTS.DWG Saved: 7/7/2009 12:02:54 PM Plotted: 7/10/2009 1:47:26 PM User: Filkins, Rebecca

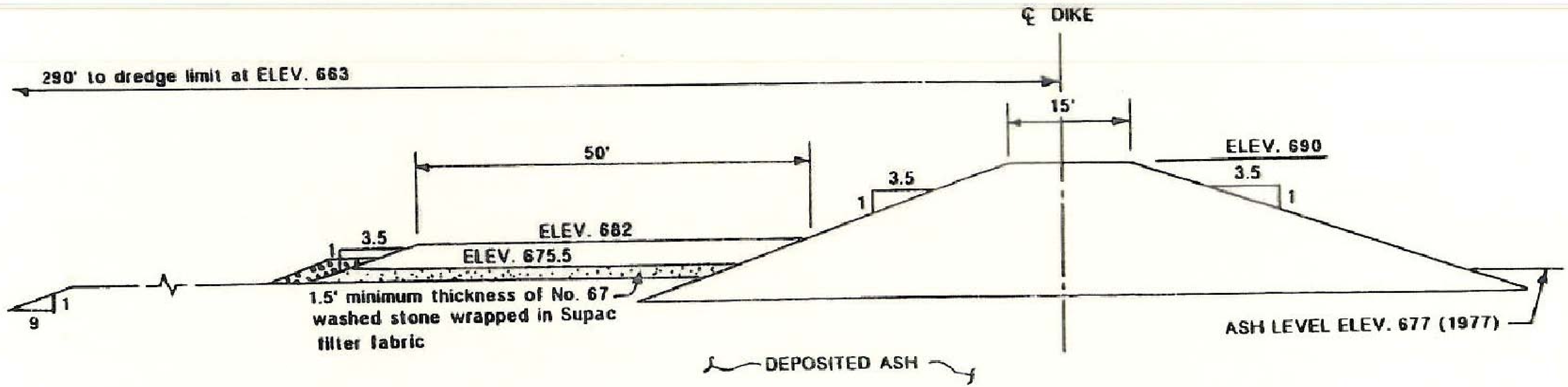


IMAGE REFERENCE: 6234-05-3350 BUCK STEAM STA.,
FIGURE 6

CHA

CROSS SECTION OF DIVERTER DIKE
BUCK STEAM STATION
DUKE ENERGY
SPENCER, NORTH CAROLINA

PROJECT NO. 20085.5000

DATE: JULY 2009

FIGURE 5

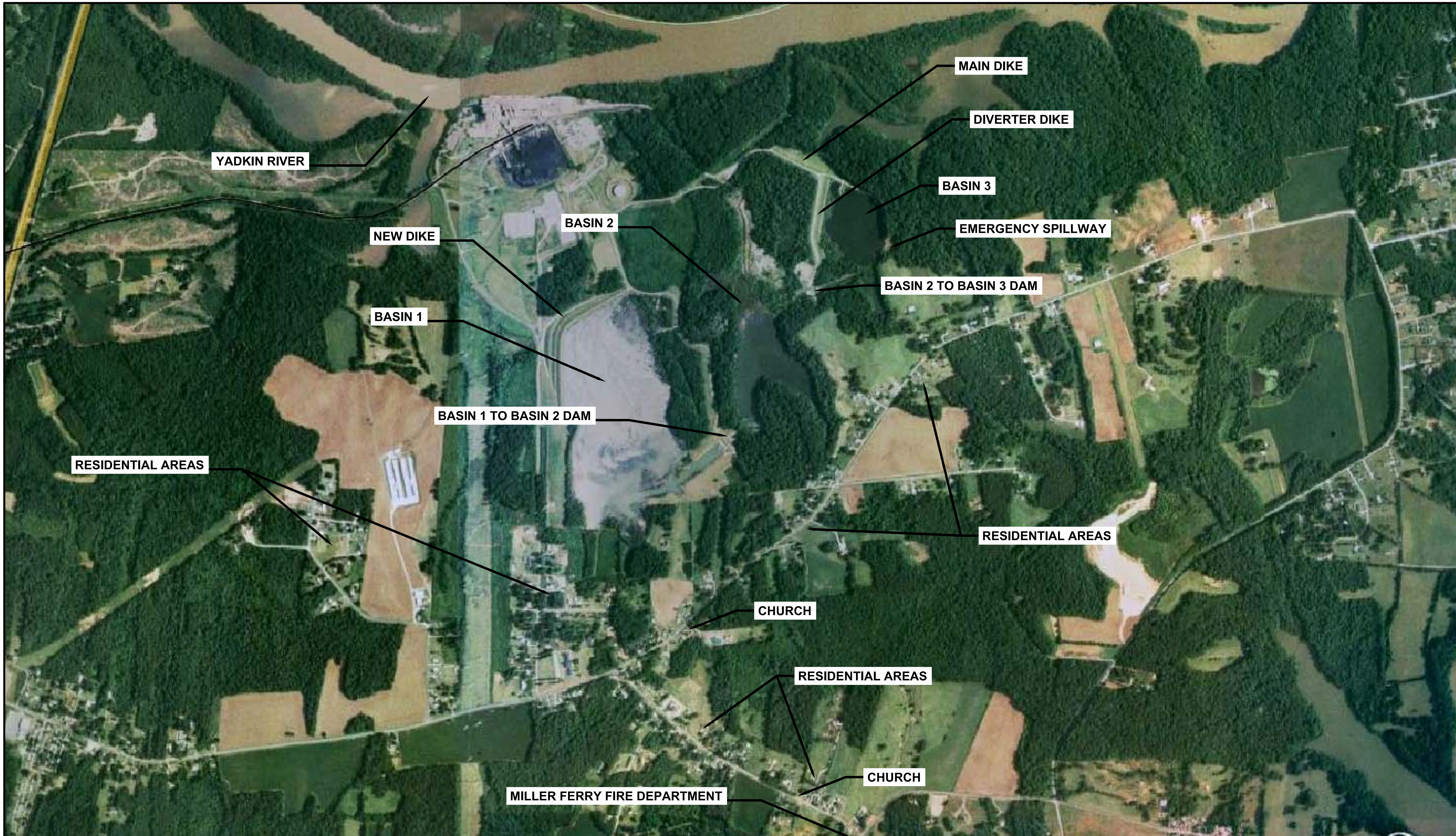


IMAGE REFERENCE: GOOGLE EARTH, IMAGE DATED JULY 2006.

0 1060 2120
Scale in feet

N

Drawing Copyright © 2007 CHA

CHA

CRITICAL INFRASTRUCTURE MAP
BUCK STEAM STATION
DUKE ENERGY
SPENCER, NORTH CAROLINA

PROJECT NO. 20085.5000	
DATE: JULY 2009	
FIGURE 6	

2.0 FIELD ASSESSMENT

2.1 Visual Observations

CHA made visual observations of the new dike, main dike, diverter dike, Basin 1 to 2 outlet dam, and Basin 2 to 3 outlet dam following the general procedures and considerations contained in Federal Emergency Management Agency's (FEMA's) *Federal Guidelines for Dam Safety* (April 2004), and Federal Energy Regulatory Commission (FERC) Part 12 Subpart D to make observations concerning settlement, movement, erosion, seepage, leakage, cracking, and deterioration. A Coal Combustion Dam Inspection Checklist and Coal Combustion Waste (CCW) Impoundment Inspection Form, prepared by the US Environmental Protection Agency, was completed on-site during the site visit. Copies of these completed forms were submitted via email to a Lockheed Martin representative approximately three days following the site visit to the Buck Steam Station. Copies of these forms are included in Appendix A. A photo log and Site Photo Location Maps (Figure 7A through 7D) are located at the end of Section 2.5.

CHA's visual observations were made on June 9, 2009 and June 10, 2009. The weather was sunny with temperatures between 65 and 90 degrees Fahrenheit. Prior to the days we made our visual observations the following approximate rainfall amounts occurred (as reported by www.weather.com).

Table 2– Approximate Precipitation Prior to Site Visit

Date of Site Visit - June 9, 2009 & June 10, 2009		
Day	**Date**	**Precipitation (inches)**
Tuesday	6/2/09	0.00
Wednesday	6/3/09	0.14
Thursday	6/4/09	1.78
Friday	6/5/09	1.01
Saturday	6/6/09	0.00
Sunday	6/7/09	0.00
Monday	6/8/09	0.00
Tuesday	6/9/09	0.00
Wednesday	6/10/09	0.36
Total	**Week Prior to Site Visit**	**3.29**
Total	**Month of May**	**2.16**

2.2 Visual Observation – New Dike

CHA performed visual observations of the new dike. The new dike is about 2,070 feet long and about 72 feet high. The new dike comprises the north side and half of the west side of Basin 1.

2.2.1 Embankments and Crest

In general, the alignment of the new dike crest does not show signs of change in its horizontal alignment. No evidence of prior releases, failures or patchwork on was observed at the time of the site visit. Photos 2 and 23 show the north and west portions of the new dike crest alignment, respectively.

The upstream slope was covered with appropriate grass vegetation. Sluiced ash deposited higher than the current water level is adjacent to the upstream slope of the new dike. There are taller weeds growing on the ash adjacent to the dike slope. Photos 3 and 4 show the upstream slope along the north portion of the new dike.

The downstream slope of the new dike was constructed with two benches at elevations 690 and 670 (as compared to the dike crest at elevation 710). Each bench has a drainage swale, which in some areas is rip rapped and in some areas is grass lined, and culverts at low points along the bench swale discharge the collected surface runoff to the bench or toe drainage swale below. Photos 8, 12, 20, and 21 show examples of these drainage culverts. As can be seen in Photo 7, the drainage swales have areas where surface runoff has deposited sediment, clogging the rip rap. Although each swale has silted in to varying degrees, this is a common feature at the new dike.

The downstream slope was reasonably uniformly graded, and covered with appropriate grass vegetation. There are occasional areas where the grass is sparse, such as those areas shown in Photos 10 and 13.

Seepage is occurring at the toe of the new dike at the northwest corner, which also happens to be the highest section. The seepage area extends between the culvert crossing under Dukeville Road and about 100 feet northeast along the toe drain swale. Photos 17 and 18 show this general area where an obvious seep was occurring, and multiple wet areas where it appeared seepage may have been occurring. The seepage flow was clear. Duke Energy personnel indicated that they had been having discussions with an outside consultant to design a seepage monitoring system. Because there was no monitoring device collecting the seepage, and over 3 inches of rain had fallen in the week prior to our site visit, an estimate of the seepage volume was not made.

2.2.2 Basin 1 to Basin 2 Outlet Control Structure and Discharge Channel

Because of the layout of the sedimentation ponds at the Buck Steam Station, the outlet control structure for Basin 1 is not adjacent to the main dike but is created by an earthen dam in a channel below original ground with a control structure and discharge pipe at the southeast corner of Basin 1. The discharge tower is shown in Photo 24.

The outlet control structure controls the water level in Basin 1 via stop logs in an overflow weir. The water then discharges through a 36-inch diameter concrete pipe into Basin 2. As can be seen in Photo 25, the stop log system experiences significant leakage resulting in the lowering of water in Basin 1 below the normal decant elevation when ash is not being actively sluiced into Basin 1. During our visit, the Buck Steam Station was not generating power so no ash was being sluiced into Basin 1.

Photos 26 and 27 show the downstream end of the outlet pipe, and the discharge channel between the outlet pipe and Basin 2. Seepage was noted adjacent to the downstream end of the outlet pipe headwall. This seepage flow appeared clear at the time of the site visit.

2.2.3 Basin 1 to Basin 2 Outlet Dam

The Basin 1 to Basin 2 Outlet Dam is about 260 feet long. The crest is at El. 710 per design drawings; the same as the new dike. Photos 24 and 25 show this structure. No evidence of prior releases, failures or patchwork on was observed at the time of the site visit. Failure of this structure would not release impounded fluid or materials outside of the basin system although this is discussed further in Section 3.4.

2.3 Visual Observations – Main Dike

CHA performed visual observations of the main dike. The main dike was originally constructed in 1956 and partially raised in 1977. It is about 1,900 feet long with a maximum height of about 70 feet.

2.3.1 Embankments and Crest

There are two portions of the main dike. The first portion is about 1,350 feet long and impounds the north side of Basin 2 and Basin 3. The crest adjacent to Basin 2 was raised in 1977 when Basin 3 was created from part of the original ash pond for secondary sedimentation prior to effluent discharge to the Yadkin River.

The second portion is about 550 feet long and extends from the northeast corner of Basin 3 to the emergency spillway. The second portion of the dike has been neglected and is significantly overgrown with trees. The berm is about 5 feet high and at the water levels during our site visit was not impounding water. The following paragraphs refer to the first portion of the main dike, which is maintained by Duke Energy.

In general, the alignment of the crest of the main dike does not show signs of change in horizontal alignment. No evidence of prior releases, failures or patchwork on was observed at the time of the site visit. Photos 31 through 33 show the general condition of the main dike crest.

At one location on the downstream edge of the main dike crest, as shown in Photo 49, a low spot has developed. This area is approximately across the crest from the path leading to the outlet tower, although because of the location of the path and angle at which the outlet pipe penetrates the dike, this low spot does not appear to be related to the outlet works.

Although difficult to distinguish in the photograph, Photo 34 is typical of the conditions of the second portion of the main dike.

The upstream slope of the main dike adjacent to Basin 3 was relatively uniform although the slope angle ranged from the 3H:1V shown on construction plans to about 2.4H:1V. Photo 35 shows this area. Beach erosion has occurred at the water line, particularly around weed clumps and there are areas of sparse grass cover and signs of animal digging on the slope as shown in Photos 36 through 38.

The upstream slope of the main dike adjacent to Basin 2 is reasonably uniform as shown in Photo 40. The trees seen here are growing in the ash deposited prior to Basin 2 being abandoned in 1985 when Basin 1 was constructed.

The downstream slope of the main dike is reasonably uniform as shown in Photos 41, 44, 48, 50 and 51. Areas of sparse grass coverage were noted as shown in Photos 42, 45, 47 and 50. Areas of animal disturbance were noted in fire ant mounds and by digging turtles (Photo 43).

2.3.2 Main Dike (Basin 3) Outlet Control Structure

The outlet control structure for Basin 3 penetrates the main dike. The control structure has two weir drop inlets that are controlled with concrete stop logs. Timber trash racks have been installed above the stop logs, and can be lifted out in the same manner as the stop logs if adjustment of the stop log elevation is required. Photo 52 shows the outlet structure and Photo 53 shows a trash rack.

Outflows from Basin 3 are conveyed through a 36-inch diameter corrugated metal pipe. The discharge point at the downstream toe is shown in Photo 54, where the discharge flows through a V-notch weir structure into a concrete lined channel. The last section of the concrete channel has separated as shown in Photo 56, and has experienced slight undermining. Other joints in the concrete channel appear to have settled slightly and baffles have been placed to prevent splashout from the channel, which appears to have been problematic in the past.

2.3.3 Basin 2 to Basin 3 Outlet Dam

The south end of Basin 2 receives outflow from Basin 1 which then passes into Basin 3 through an excavated channel. Flow is controlled through the Basin 2 to 3 outlet dam and control structure. No evidence of prior releases, failures or patchwork on was observed at the time of the site visit. Photo 62 shows the outlet control structure, which has significant vegetation growth around it growing in deposited ash. An animal slide (likely muskrat or beaver) was noted on the downstream slope of the outlet dam as shown in Photo 65. The downstream end of the outlet pipe into Basin 3 was submerged at the time of our visit. Photos 67 and 68 show the discharge end of the pipe, and the channel to Basin 3 downstream of the outlet dam, respectively.

2.4 Visual Observations – Diverter Dike

The other feature separating Basin 2 from Basin 3 is the diverter dike. This dike was constructed in 1977 to create the secondary settling capacity in what is now called Basin 3 and was constructed over deposited ash. Previous inspection reports note boils near the intersection of the diverter dike and the upstream slope of the main dike. Rip rap was placed in this area, and subsequently Basin 2 was discontinued for ash disposal which has reduced the differential head between the up and downstream sides of the diverter dike. CHA did not observe evidence of these boils.

The crest of the diverter dike appeared reasonably uniform as compared with original construction drawings as shown in Photo 69. No evidence of prior releases, failures or patchwork on was observed at the time of the site visit. Several areas of erosion swales and/or settlement at the toe of the diverter dike were noted such as shown in Photos 72 and 74. These depressions were up to 8 inches deep. At some, but not all, of these depressions, surface ponding in ruts on the dam crest was noted. There is a 50-foot bench between the toe of the diverter dike and the water’s edge in Basin 3. The upstream slope is reasonably uniform as shown in Photos 75 and 76. The trees seen in these photographs are on the deposited ash in Basin 2.

2.4.1 Basin 3 Emergency Spillway

An emergency spillway was constructed at the east side of Basin 3 as shown on Figure 2A. The emergency spillway is grass covered about 150 feet before entering a wooded area where the natural ground slopes down to the Yadkin River. Areas of the grass coverage were sparse as shown in Photo 82. A fence constructed across the emergency spillway for previous demarcation activities presents a potential debris clogging hazard.

2.4.2 Basin 2 Yard Sump Disposal Point

Photos 83 through 86 show the area in the northern portion of Basin 2 where ash was sluiced into the basin prior to 1985. The only discharge to this portion of the basin now is from the Station yard sumps. Duke Energy personnel reported that ponding of the water was problematic so several years ago an ash berm and swale were constructed to convey the yard sump discharge to the south end of Basin 2.

2.5 Monitoring Instrumentation

There are piezometers located on the new dike, the main dike, diverter dike and on the Basin 2 to Basin 3 outlet dam. The locations of the piezometers are shown on Figure 10. Data for the piezometers is presented for the last 24 years in Figures 8A through 8G and pond elevations are shown on Figures 9A and 9B. A more complete discussion of the data collected from this instrumentation is contained in Section 3.4.

There are nine settlement points that are monitored periodically by Duke Energy for settlement at the new dike. Settlement points are located along the crest, the 690' berm and the 670' berm. The locations of the settlement points are shown on Figure 10 and Figures 11A to 11E are plots of the settlement point readings. Reportedly there were four settlement monitoring points located on the divider dike; however it is our understanding that these points are no longer available to be read.

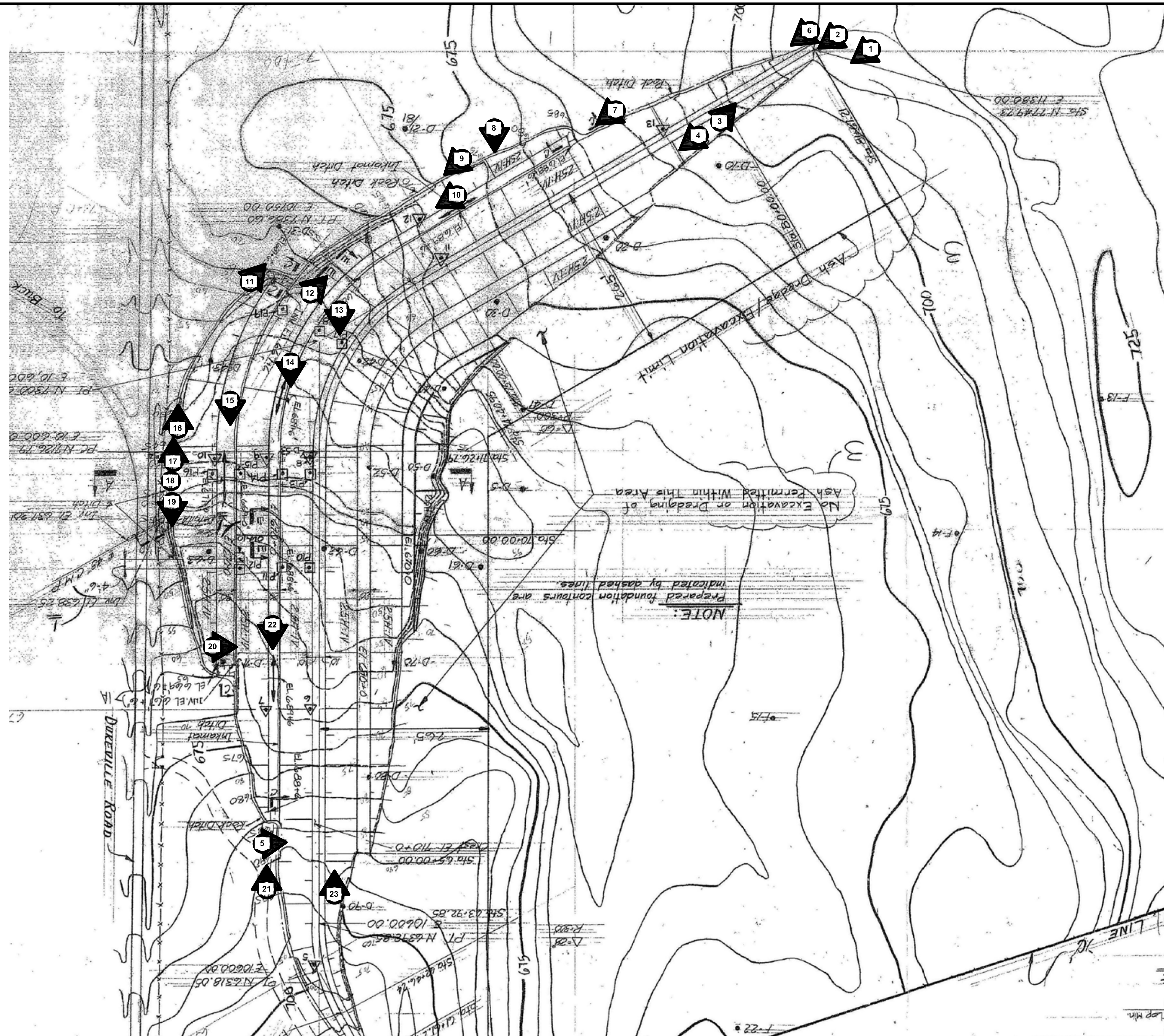


IMAGE REFERENCES: 1982 B-3039-D2 ASH STORAGE

N

Drawing Copyright © 2007 CHA

CHA

PHOTO LOCATION PLAN
NEW DIKE
BUCK STEAM STATION
DUKE ENERGY
SPENCER, NORTH CAROLINA

PROJECT NO. 20085.5000

DATE: JULY 2009

FIGURE 7A

File: K:\20085\CADD\ACAD\FIGURES\GEO\5000 BUCK\5000 BUCK PLANS-MAPS.DWG Saved: 7/10/2009 3:41:54 PM PLotted: 7/13/2009 12:41:14 PM User: Filkins, Rebecca

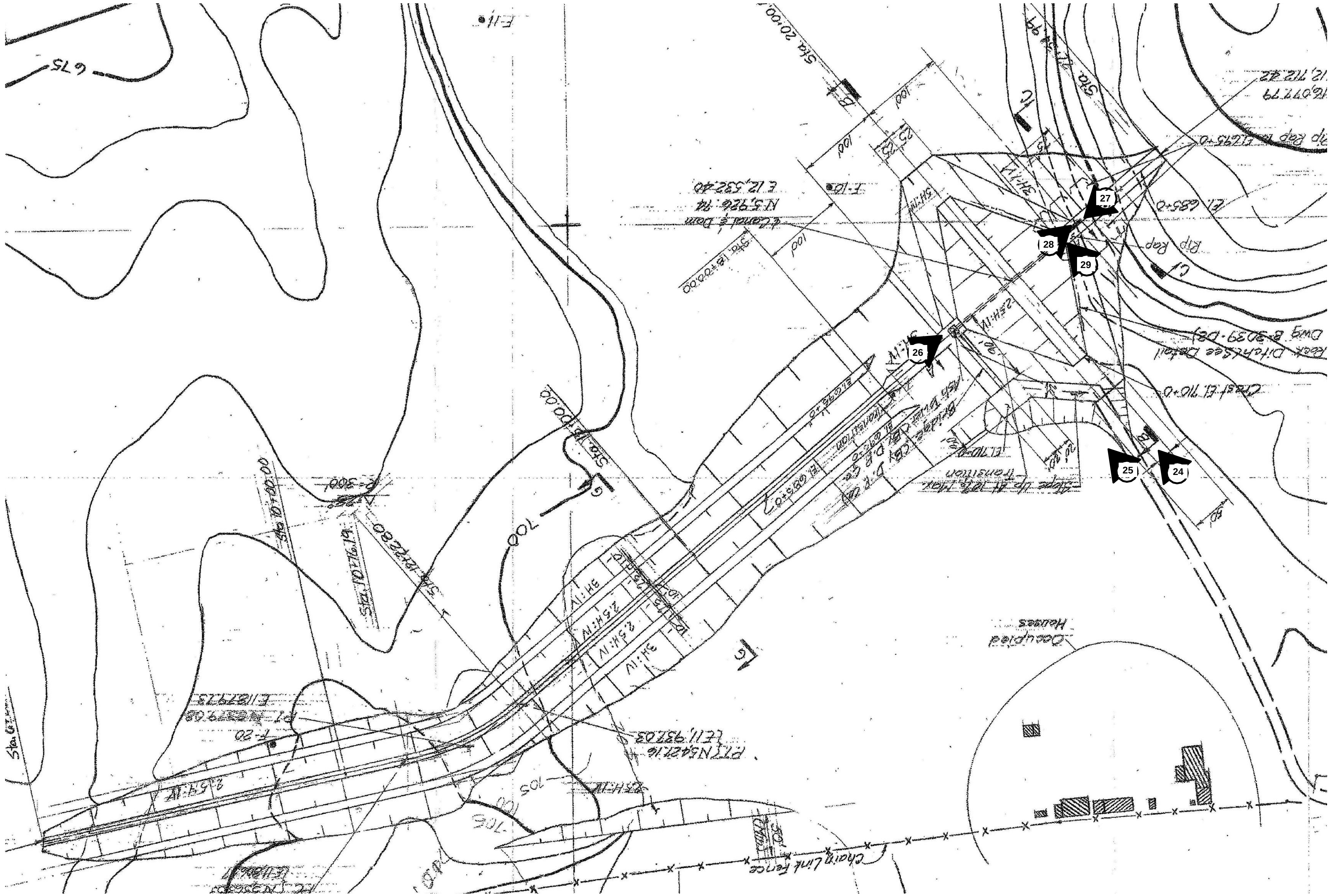


IMAGE REFERENCES: 1982 B-3039-D1 ASH STORAGE

Drawing Copyright © 2007 CHA

CHA

PHOTO LOCATION PLAN
BASIN 1 TO BASIN 2 DAM
BUCK STEAM STATION
DUKE ENERGY
SPENCER, NORTH CAROLINA

PROJECT NO. 20085.5000

DATE: JULY 2009

FIGURE 7B

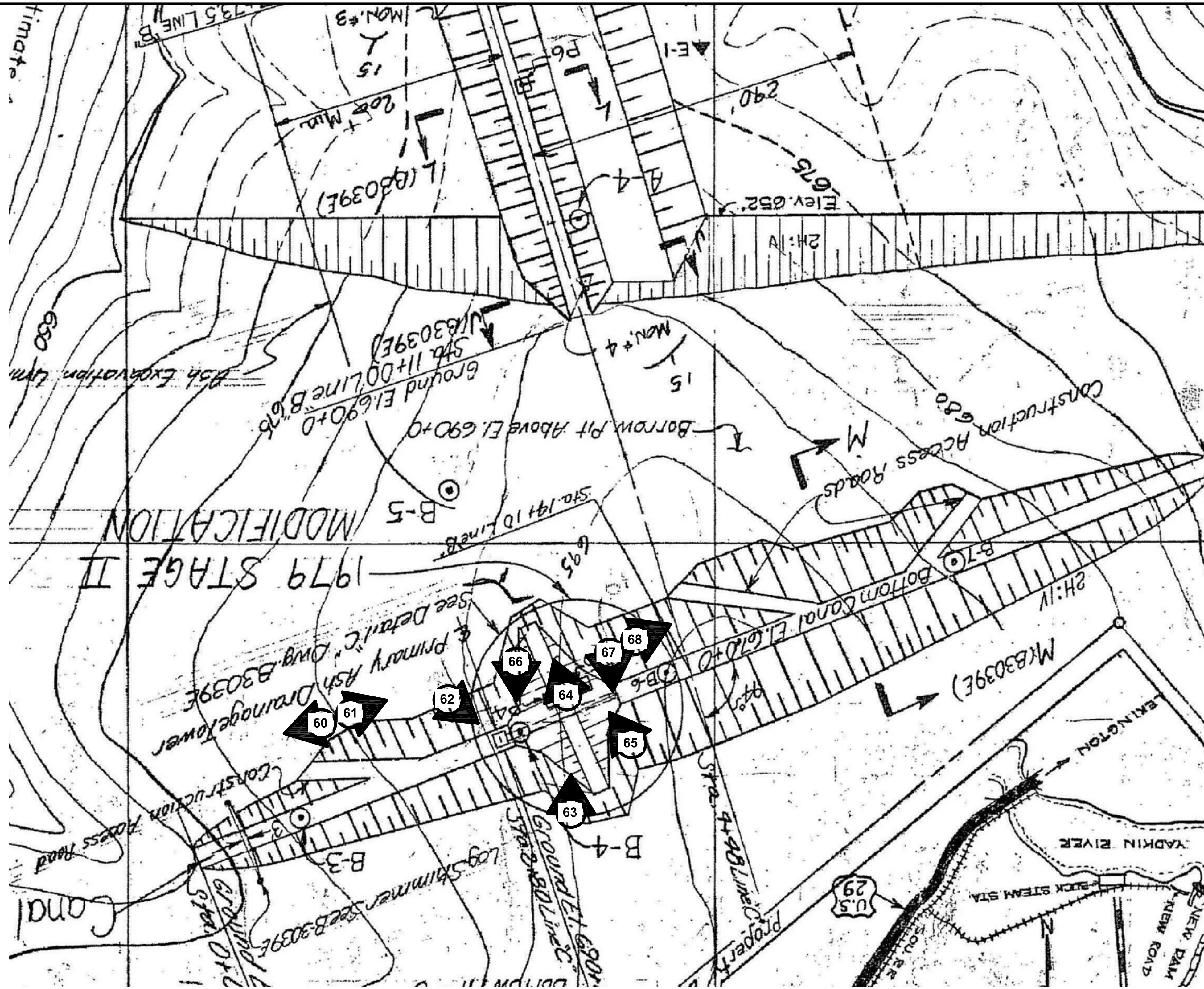


IMAGE REFERENCES: 1956 B-3039-D NEW ASH

Drawing Copyright © 2007 CHA

CHA

PHOTO LOCATION PLAN
BASIN 2 TO BASIN 3 DAM
BUCK STEAM STATION
DUKE ENERGY
SPENCER, NORTH CAROLINA

PROJECT NO.
20085.5000

DATE: JULY 2009

FIGURE 7C

File: K:\20085\CADD\ACAD\FIGURES\GEO\5000 BUCK\5000 BUCK PLANS-MAPS.DWG Saved: 7/10/2009 3:41:54 PM PLotted: 7/13/2009 1:08:24 PM User: Filkins, Rebecca

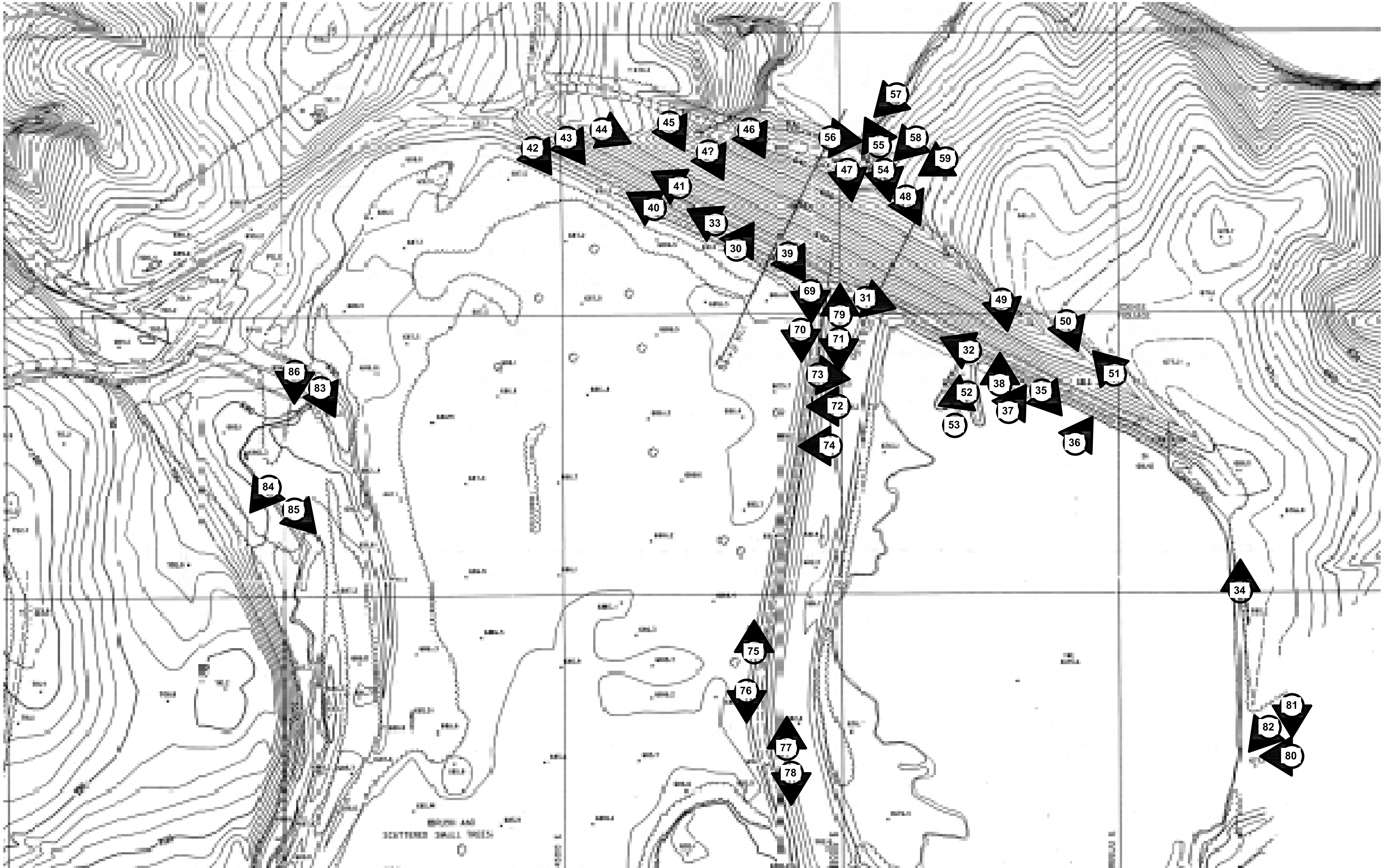


IMAGE REFERENCES: TOPOGRAPHIC MAP OF DUKE POWER COMPANY BUCK STEAM STATION

Drawing Copyright © 2007 CHA

CHA

PHOTO LOCATION PLAN
MAIN DIKE & DIVERTER DIKE
BUCK STEAM STATION
DUKE ENERGY
SPENCER, NORTH CAROLINA

PROJECT NO. 20085.5000

DATE: JULY 2009

FIGURE 7D

1

Basin 1 from North Abutment looking southwest. CCW sluice pipes in foreground.

2

New Dike crest looking southwest (from North Abutment).

3

New Dike crest and upstream slope looking northeast towards North Abutment (note van is on abutment).

4

New Dike crest and upstream slope looking southwest.

5

Downstream slope and crest of New Dike looking north from near South Abutment.

6

Downstream Slope looking southwest from North Abutment. Note "gray" rip rap swale is groin drainage swale associated with the New Dike, the "white" rip rap to the right is a surface drainage swale associated with the combined cycle plant currently under construction. Hill in near right of photo is a stockpile of excavated material from the combined cycle plant construction.

7

Drainage swale at north end of upper bench clogged with silt.

8

Upper bench drainage swale culvert discharging into toe swale.

9

Downstream slope and toe drainage swale along northern portion of the New Dike looking southwest.

10

Dowstream Slope at Upper Bench of New Dike looking southwest. Note occasional sparse grass cover.

11

Toe of New Dike looking northeast. Toe drainage swale is in right of photo, slope down to the left is natural ground cut to new combined cycle plant site.

12

Surface drain from Upper Bench. Downstream Slope looking northeast.

13

Downstream Slope of New Dike looking south. Note sparse grass coverage in some areas.

14

Downstream Slope of New Dike from Upper Bench looking south.

15

Lower Bench of New Dike looking south. Note silt deposited in drainage swale.

16

Toe swale of New Dike looking north. Note drainage pipe entering drainage swale from across access road to new combined cycle plant site. Sparse vegetation along rip rap edge likely from herbicide use to control weeds in the rip rap.

17

Toe swale of New Dike looking north. Area of toe drain seepage. Area starts about 100 feet north of discharge culvert under Dukeville Road.

18

Closeup of toe drain seepage at New Dike. Water was flowing clear. Reportedly Duke Energy is in the process of discussing installation of a seepage monitoring system with an outside consultant.

19

Drainage swale at toe of New Dike looking south.

20

Repair area where surface runoff was causing sloughing from Upper Bench to Lower Bench. Repair was completed between 1993 and 1998 based on publically available aerial photos.

21

Downstream Slope of New Dike looking north from Lower Bench of New Dike.

22

Downstream Slope of New Dike looking south to South Abutment. Note contractor laydown area is beyond the Dike.

23

Upstream slope and crest alignment of west portion of New Dike, looking north.

24

Outlet dam from Basin 1 to Basin 2 looking north. This dam is in a cut channel created to drain Basin 1 into Basin2 through a high point in the natural topography.

25

Basin 1 Outlet Tower.

26

Stoplogs in Basin 1 Outlet Tower. During these observations the Buck Plant was not generating power, therefore they were not sluicing CCW into Basin 1. Leakage between the stoplogs had resulted in a lowering of the Basin 1 water level below the normal decant elevation.

27

Downstream end of Basin 1 outlet pipe.

28

Basin 1 to Basin 2 outlet channel looking toward Basin 2.

29

Seepage noted adjacent to downstream end of outlet pipe headwall.

30

Yadkin River back water from crest of Main Dike, looking northeast.

31

East portion of Main Dike crest adjacent to Basin 3, looking east.

32

Middle portion of Main Dike crest and upstream slope adjacent to Basin 3, looking west. Van is parked on the diverter dike.

33

West portion of Main Dike crest adjacent to Basin 2, looking west.

34

Main Dike extended all the way to the emergency spillway. Overgrown portion not impounding water during normal pool operations.

35

Upstream slope of Main Dike adjacent to Basin 3, looking east.

36

Close up of poor vegetation cover area.

37

Close up of animal disturbance (possibly turtle nest).

38

Close up of poor vegetation cover area.

39

Upstream slope of Main Dike adjacent to Basin 2 and Diverter Dike, looking south.

40

Upstream slope of Main Dike, adjacent to Basin 2, looking west.

41

Downstream slope of Main Dike adjacent to Basin 2, looking west.

42

Close up of poor vegetation cover on downstream slope of Main Dike.

43

Close up of animal disturbance on downstream slope of Main Dike.

44

Downstream slope of Main Dike from West Abutment, looking east.

45

Close-up of sparse vegetation cover.

46

Clogged groin drainage swale on west end of Main Dike. Sediment appeared to include bentonite chips, possible runoff from poorly cleaned up drilling at "new" monitoring wells.

47

Sparse vegetation at toe of Main Dike near the outlet structure.

48

Downstream slope east of the outlet structure, looking east.
Note: Rip rap is groin drainage swale. Duke Energy uses herbicide to control vegetation in rip rap.

49

Low spot at crest, as seen from toe of Main Dike, location is adjacent to Basin 3.

50 

Sparse vegetation on downstream slope at east end of maintained Main Dike, looking east.

51 

Herbicide treated vegetation in groin swale at the east end of Main Dike.

52

Outlet control structure in Basin 3. Structure is surrounded in Y-shaped berm system, not part of the Main Dike.

53

Timber trash rack sits on stop logs in Basin 3 outlet structure and can be easily removed if adjustment of stop log elevation is required.

54

Discharge end of Basin 3 outlet.

55

Discharge from Basin 3 in concrete lined channel discharges into Yadkin River backwater.

56

Last section of concrete channel has separated. Noted in previous inspection reports.

57

Slight undermining of concrete discharge channel at river end.

58

Slight undermining of concrete discharge channel at outlet structure.
Baffles in place to control splash out of channel during high flows.

59

Main Dike outlet pipe headwall and ph treatment.

60

Channel from Basin 2 approaching outlet control structure.

61

Basin 2 outlet control structure. Note: Photographer at rim of channel excavated into natural ground.

62

Basin 2 outlet control structure. Vegetation at base of tower and access bridge is on deposited ash.

63

Crest of Basin 2 to Basin 3 outlet dam, looking north.

64

Downstream slope of Basin 2 to Basin 3 outlet dam, looking north.

65

Animal trail on downstream slope of Basin 2 to Basin 3 outlet dam.

66

Upstream slope of Basin 2 to Basin 3 outlet dam, looking south.

67

Basin 2 outlet pipe submerged on downstream end.
Note: Headwall visible at water surface.

68

Downstream discharge channel from Basin 2 outlet. Plans indicate channel was excavated into natural ground.

69

Crest of Diverter Dike which separates Basin 2 from Basin 3, looking south from Main Dike.

70

Upstream (Basin 2 side) slope of Diverter Dike, looking south.

71

Downstream (Basin 3 side) slope of Diverter Dike, looking south.
Note: Diverter Dike was constructed with a 50-foot wide bench at the Basin 3 toe of slope.

72

Erosion swale on downstream slope of Diverter Dike.

73

North end of toe bench on Diverter Dike, looking east.

74

More erosion or settlement locations on downstream slope of Diverter Dike
as noted by clipboard and dark green grass to left of clipboard.

75

Upstream slope of Diverter Dike from bend, looking north towards Main Dike.

76

Upstream slope of Diverter Dike from bend, looking south.

77

Downstream slope of Diverter Dike, looking north towards the Main Dike.

78

Downstream slope of Diverter Dike, looking south.

79

Diverter Dike/Main Dike contact.
Note: Main Dike is higher at Basin 2 (left in photo) than at Basin 3 (right in photo).

80

Emergency Spillway, looking west at Basin 3.

81

Fence across Emergency Spillway.
Note: Emergency Spillway flows into wooded area to left in photo.

82

Sparse vegetation within Emergency Spillway.

83

Dike through Basin 2 for access on inactive portion of Basin. Yard sumps discharged into channel in Basin 2 to right in photo, looking south.

84

Ash Dike to control flows and prevent standing water in area of yard sump discharge.

85

Ash Dike to control flows and prevent standing water in area of yard sump discharge.

86

Yard sump discharged point on north end of Basin 2.

3.0 DATA EVALUATION

3.1 Design Assumptions

CHA has reviewed the design assumptions related to the design and analysis of the stability and hydraulic adequacy of the main dike, new dike, and diverter dike which were available at the time of our site visits and provided to us by Duke Energy. The design assumptions are listed in the following sections.

3.2 Hydrologic and Hydraulic Design

The new and main dikes have been classified as High Hazard by NCUC in accordance with North Carolina Dam Safety Regulations. As such, based on the height of the dikes and their hazard classification, these facilities are required to safely pass or store the inflows resulting from ¾ of the Probable Maximum Precipitation (PMP) in accordance with North Carolina Dam Safety regulations.

Duke Energy provided CHA with a hydrology and hydraulics analysis that was performed for Basin 1. This analysis concluded that Basin 1 does safely store the ¾ PMF. The available freeboard was less than one foot at the operating normal pool at that time, and the North Carolina Utilities Commission requested that the operating level of the pool be changed so that more than 1 foot of freeboard would be available during the ¾ PMF. Duke Energy removed one stop log from the Basin 1 to 2 outlet tower, which lowered the normal operating pool 9 inches (the width of the stop log) and leaves 1.6 feet of freeboard during the ¾ PMF.

No analyses were provided to CHA for Basins 2 and 3. Each of these basins has an independent drainage area and receives inflow from the previous basin. CHA developed a preliminary hydrologic and hydraulic model based on observations made in the field, construction plans.

This model suggests that during the ¾ PMF the water levels in the basins will rise to the following elevations:

- Basin 1 – El. 708.1 (consistent with Duke Energy calculations and level of detail in model)
- Basin 2 – El. 689.4
- Basin 3 – El. 678.3

While these elevations are below the crests of the respective dikes, this model suggests that only 0.6 feet of freeboard is available in Basin 2.

3.3 Structural Adequacy & Stability

The North Carolina Department of Environmental and Natural Resources (NCDENR), Land Quality Section, Dam Safety Program regulations require, as shown in Table 3, "a minimum factor of safety of 1.5 for slope stability for normal loading conditions, and 1.25 for quick (rapid) drawdown conditions and for construction conditions", unless the design engineer provides a thoroughly documented basis for using other safety factors.

Table 3 - Minimum Safety Factors Required by NCDENR

Load Case	Required Minimum Factor of Safety
Steady State Conditions at Present Pool or Flood Elevation	1.50
Rapid Draw-Down Conditions from Present Pool Elevation	1.25

NCDENR regulations also state that "Foundation bearing capacity and sliding base analyses should be considered for all dams and may be required for class B and C dams. Where bearing capacity or sliding base analyses are required, documentation of assumptions, computations, and safety factors shall be included in the final design report. A minimum factor of safety against bearing capacity and sliding wedge failure of 2.0 shall be required unless the design engineer provides a thoroughly documented basis for using other safety factors."

Additional industry guidelines such as those published in the United States Army Corps of Engineers EM 1110-2-1902, Table 3-1 suggest the following guidance values for minimum factors of safety as shown in Table 4.

Table 4 - Minimum Safety Factors Recommended by US Army Corps of Engineers

Load Case	**Required Minimum Factor of Safety**
Maximum Surcharge Pool (Flood) Condition	1.4
Seismic Conditions from Present Pool Elevation	1.0

CHA reviewed inspection reports for the Buck Steam Station provided by Duke Energy. A summary of the stability analyses results outlined in these reports is provided in Table 5.

Table 5- Summary of Historic Stability Analyses (Factors of Safety)

	1986 Rapid Drawdown	**1986 Steady State (DS Slope)**	**1996 Steady State (DS Slope)**	**2004 Steady State (DS Slope)**	**2009 Steady State (DS Slope)**	**CHA Steady State (DS Slope)**
New Dike	1.5	1.8	1.5[A]	1.6[B]	NP	1.5✦ 1.8✦✦
Main Dike ▪ Primary Cell (Basin 2) ▪ Secondary Cell (Basin 3)	1.9 3.3	1.5 3.1	1.4[C] 2.0[D]	NP NP	1.7* 1.5** NP	1.6 1.9
Divider Dike ▪ US Slope ▪ DS Slope	2.10 1.94	1.92	NP	NP	NP	NP
Primary Drainage Tower Dike	1.73	1.83	NP	NP	NP	NP

Notes: NP – Not performed.
[A] - Sta. 69+50, Pond 695'
[B] - Sta. 71+00, Pond 705'
[C] - Sta. 5+40, Pond 675'
[D] - Sta. 7+50, Pond 675'
* - Stability analysis performed using pheratic surface based on available data (June 2008).
** - Stability analysis performed using a high water condition. See Section 3.3.2.2.
✦ – Pheratic level model as design pheratic surface (See Section 3.3.15).
✦✦ – Pheratic level model from current piezometer data (See Section 3.3.15).

Sections 3.3.1, 3.3.2, and 3.3.3 discuss our review of the effects of overtopping, stability analyses, and performance of the new (additional primary), the main, and diverter dikes, respectively.

3.3.1 New Dike

3.3.1.1 1985 Independent Inspection

A 1985 independent inspection report recommended that further engineering studies be performed by Duke Energy to investigate the previously selected soil parameters, stratifications and water levels that were above the design pheratic surface in piezometers P12, P15, P16 and P19 of the new dike. It was reported that Duke Energy performed this analysis in 1986 (Duke's Calculation File BC-232). CHA was not provided with a copy of the referenced analysis nor the 1985 inspection report.

A later inspection report noted that the rapid drawdown analyses performed by Duke Energy in 1986 were viewed as conservative because they were based on a minimum drawdown of 10 feet, which is not attainable under normal operating conditions. Based on CHA's observations, under current conditions this is an appropriate conclusion.

3.3.1.2 February 1996 Analysis

In February 1996 Duke Energy performed stability calculations for the downstream slope of the new dike at Stations 69+50, 71+00 and 73+00 using a pheratic line as determined by even higher piezometer and observation well readings obtained since 1986. Outputs from these analyses are shown on Figures 12A, 12B and 12C. Station 69+50 exhibited the lowest safety factor with a 1.5, which meets NC Dam Safety requirements.

3.3.1.3 December 2004 DTA Analysis

In 2000 it was recommended that filter fabric be removed from around rip rap at the toe drain in order to allow the blanket drain to flow more freely and thus lower the pheratic surface below that used in the calculations. The filter fabric was reportedly removed in early 2004 resulting in a drop in the pheratic surface as desired. In December 2004, Devine Tarbell & Associates, Inc. (DTA) analyzed the slope stability of the new dike at Station 71+00 with full pond level of 705 feet. Embankment geometry, piezometers levels, engineering soil parameters, and other relevant information were taken from references provided by Duke Energy. An increased factor of safety of 1.6 for the new dike, with the pond level at Elevation 705 feet (10 feet higher than used for the previous analysis with a calculated lower factor of safety of 1.5) was calculated.

3.3.1.4 2008 Annual Inspection Ash Basin Dike Inspection Report

The sixth independent consultant inspection report for the Buck Steam Station, prepared by Mactec Engineering and Consulting, Inc., recommended that the annual inspection include a review of the piezometers data to ensure the pheartic surface is maintained below the level assumed in the 2004 stability analysis for the new dike.

The piezometers readings, provided by Duke, for the period January 2005 to June 2008 were reviewed and compared as part of the scope of work in the 2008 annual inspection report. The report outlines that the maximum piezometric level for piezometers P13 and P14 have exceeded the values associated with a pond elevation of 705 feet, however, the June 2008 readings had returned to below the values used in the stability analysis.

Piezometer readings in P15 and P16 were higher than the values used in the stability analysis. The 2008 annual inspection report notes that in February 2007 both of these piezometers experienced increase readings of approximately 5 feet from the previous month's readings. The pond elevation in the additional primary pond was increased from around 701.5 feet in late 2006 to an elevation of 703.9 feet in February 2008. The inspection report notes in Section 6, Table 3, Item 1 that piezometers P15 and P16 were found to be damaged and recommended that the piezometers be abandoned and new ones installed with screens at the same elevations.

3.3.1.5 CHA Stability Analyses - New Dike

CHA, using the new dike geometry and soil parameters provided in the DTA report dated December 2004, recreated the downstream embankment slope using the steady state load condition to confirm the factor of safety for this load case provided in the report. Soil parameters that were used in the analysis are summarized in Table 6.

Table 6 - Soil Strength Parameters Used in the 2004 DTA Report

Material	Total Unit Weight (pcf)	C (psf)	ϕ (degrees)
Embankment	123.0	0.0	33.0
Rockfill, Dumped	125.0	0.0	35.0
Filter Drain	135.0	0.0	30.0
Foundation Soils	126.0	100.0	25.0

The factor of safety for CHA's recreated analyses was calculated to be 1.5, approximately the same as previous analyses. Our Slide™ output for this analysis is shown on Figure 13. We also created a model with a pheratic surface which reflects current (May 2009) piezometers readings provided by Duke Energy for piezometers P13, P14, P15 and P16. The factor of safety was calculated to be 1.8 as shown on Figure 14.

CHA, using the recreated cross section, analyzed the seismic loading condition for the new dike. The output from our analyses is labeled as Figure 15. The seismic analyses were performed using a pseudo static analysis with a horizontal seismic coefficient of 0.0825g. This coefficient was provided in the S&ME Engineering Preliminary Engineering Study for the Proposed Buck Landfill (Appendix F). The analysis suggested a factor of safety of 1.4 which is above the recommend minimum factor of safety of 1.0.

3.3.2 Main Dike

3.3.2.1 February 1996 Analysis

In February 1996 Stations 5+40 (Primary Cell/Basin 2) and 7+50 (Secondary Cell/Basin 3) of the main dike were analyzed to study the effect of higher pheratic conditions measured since 1986. Station 5+40 exhibited the lowest safety factor with a 1.4 which is below the recommended minimum factor of safety of 1.5. Outputs from these analyses are shown on Figures 16A and 16B.

The steady state analyses in 1996 for the main dike with their minimum safety factors of 1.4 are below the recommended criteria of 1.5, but were reportedly viewed as somewhat conservative because they assume hydrostatic uplift conditions below the pheratic surface, whereas there is evidence from the instrumentation that uplift conditions at depth are somewhat below hydrostatic. Additional piezometers were installed after the fourth independent inspection report to verify uplift conditions at depth in the main dike.

3.3.2.2 Buck Landfill Preliminary Engineering Study

S&ME Engineering prepared a preliminary engineering study for the proposed Buck Landfill in January 2009. The proposed landfill would be constructed on top of the retired ash basin (Primary Cell/Basin 2). As part of the scope of work four borings were advanced at the main dike and undisturbed samples were retrieved. Laboratory testing, including natural moisture content, specific gravity, grain size analysis, Atterberg limits, and triaxial shear testing were performed on select undisturbed samples. Figure 17 summarizes the test results on the selected samples. The study included background information regarding the origin and justification for the material parameters used in the static slope stability analyses. Figure 18 summarizes the materials and parameters used for the static stability analysis.

The preliminary engineering study included slope stability analyses for long-term, and steady-state condition for the existing main dike (using Cross Section MD-A, primary cell). Figure 19 shows the section that was analyzed and the analyses results. The piezometeric surface in the main dike was generally defined by the most recent available monitoring well readings recorded in June 2008. This analysis for the long-term, steady-steady state, static condition for the existing main dike resulted in a computed critical factor of safety of 1.7 which is above the recommended factor of safety of 1.5.

A high water condition was also analyzed with the phreatic surface in the main dike established based on the 20-year high observation well readings. Figure 20 shows the section that was analyzed and the analyses results. This analysis for the long-term, steady-steady state, static condition for the existing main dike resulted in a computed critical factor of safety of 1.5 which is very close to the recommended factor of safety of 1.5, and reasonable for a temporary high water condition.

A pseudostatic stability analysis for the main dike in the existing condition was not performed as part of this study. The report included a stability analyses modeled with the completed landfill, and the calculated factor of safety was determined to be at or slightly above the minimum required factor of safety as outlined in the US ACOE guidelines.

3.3.2.3 CHA Stability Analyses for the Main Dike – Basin 2

CHA, using the main dike geometry (Cross Section MD-A) and soil parameters provided in the S&ME Engineering Preliminary Engineering Study for the Proposed Buck Landfill dated January 2009, recreated the downstream embankment slope using the steady state load condition to confirm the factor of safety for this load case provided in the report. Soil parameters that were used in the analysis are summarized in Table 7.

Table 7 - Soil Strength Parameters Used in the 2009 S&ME Report – Basin 2

Material	Total Unit Weight (pcf)	C (psf)	ϕ (degrees)
Main Dike Fill - Original	120.0	200.0	27.0
Access Road Subbase	125.0	0.0	30.0
Main Dike Fill - New	120.0	200.0	27.0
Retired Ash Basin	85.0	0.0	24.0
Alluvium/Residual	115.0	200.0	28.0
Partially Weathered Bedrock	125.0	500.0	26.0

The factor of safety for CHA's recreated analyses was calculated to be 1.6 which is comparable to the 1.7 that was reported on S&ME's 2009 report. Our Slide™ output for this analysis is shown on Figure 21.

We did not model the rapid drawdown or flood loading conditions as Basin 2 does not currently contain liquid. Instead sluiced ash with a pheratic surface approximately 13.5 feet below the top of the ash was modeled. Section 4.13 provides recommendation for additional analyses that should be preformed if current operations at the facility are modified.

CHA, using the recreated the cross section, analyzed the seismic loading condition for the main dike. The output from our analyses is labeled as Figure 22. The seismic analyses were performed using a pseudo static analysis with a horizontal seismic coefficient of 0.0825g. This coefficient was provided in the S&ME Engineering Preliminary Engineering Study for the Proposed Buck Landfill (Appendix F). The analysis suggested a factor of safety of 1.3 which is above the recommended minimum factor of safety of 1.0.

3.3.2.4 CHA Stability Analyses for the Main Dike – Basin 3

CHA, using the main dike geometry which does did not include the 1977 raised berm geometry and soil parameters provided in the S&ME Engineering Preliminary Engineering Study for the Proposed Buck Landfill dated January 2009, created a model of the downstream embankment slope using the steady state load condition to confirm the factor of safety for this load case provided in the report. No piezometers appear to be located in this area of the main dike and therefore the pheratic surface was approximated from closest piezometers, P8 and P9. Soil parameters that were used in the analysis are summarized in Table 8.

Table 8 - Soil Strength Parameters Used in the 2009 S&ME Report – Basin 3

Material	Total Unit Weight (pcf)	C (psf)	ϕ (degrees)
Main Dike Fill - Original	120.0	200.0	27.0
Access Road Subbase	125.0	0.0	30.0
Alluvium/Residual	115.0	200.0	28.0
Partially Weathered Bedrock	125.0	500.0	26.0

The factor of safety for CHA's recreated analyses was calculated to be 1.9. Our Slide™ output resulted in a similar factor of safety as shown on Figure 23.

We also modeled the rapid drawdown and flood loading conditions as Basin 3. The factors of safety were calculated to be 1.2 and 1.8, respectively. The rapid drawdown factor of safety is slightly below the NCDENR's required 1.25 and the flood condition factor of safety was above the required 1.4. Our Slide™ outputs are shown as Figures 24 and 25.

The seismic loading condition for the main dike adjacent to Basin 3 was also analyzed. The output from our analyses is labeled as Figure 26. The seismic analyses were performed using a pseudo static analysis with a horizontal seismic coefficient of 0.0825g. This coefficient was provided in the S&ME Engineering Preliminary Engineering Study for the Proposed Buck Landfill (Appendix F). The analysis suggested a factor of safety of 1.4 which is above the recommended minimum factor of safety of 1.0.

3.3.3 Diverter Dike

CHA was not provided with information regarding stability analyses performed for the diverter dike. The preliminary engineering study prepared by S&ME Engineering in January 2009 for the proposed Buck Landfill included stability analyses modeled from a cross section through the diverter (intermediate) dike for long-term and short-term conditions which included the completed landfill. As a result of current facility operations the diverter dike does not retain liquid. The dike retains sluiced ash with a water table that is approximately 13.5 feet below the surface of ash. If a failure of the dike were to occur it would most likely result in sloughing of ash from Basin 2 to Basin 3. Based on the geometry of the Diverter Dike which has a 50-foot wide bench at the toe, and the 10-foot differential elevation between Basin 2 and Basin 3, we do not expect sloughing ash to cause an overtopping flood wave in Basin 3.

3.3.4 Liquefaction Analysis

The December 2005 Five-Year Independent Consultant Inspection Report prepared by Mactec Engineering Consultants, Inc. states that the Buck Steam Station Dikes are founded primarily on residual soils, which are not generally considered susceptible to liquefaction by earthquake. Our review of available boring logs, from the site and dating from 1976 to 2008, indicate that foundations soils are most likely residual soils.

3.4 Foundation Conditions

Documents reviewed by CHA indicate that the New and Original Main Dikes, Basin 1 to 2 and Basin 2 to 3 Dams were not constructed on wet ash, slag or other unsuitable materials. The raised portion of the Main Dike (top 13 feet) was partially (upstream side) constructed on ash. The Diverter Dike was also constructed on ash.

CHA was not provided with documentation of foundation preparations for New and Original Main Dikes and the Basin 1 to 2 and Basin 2 to 3 Dams.

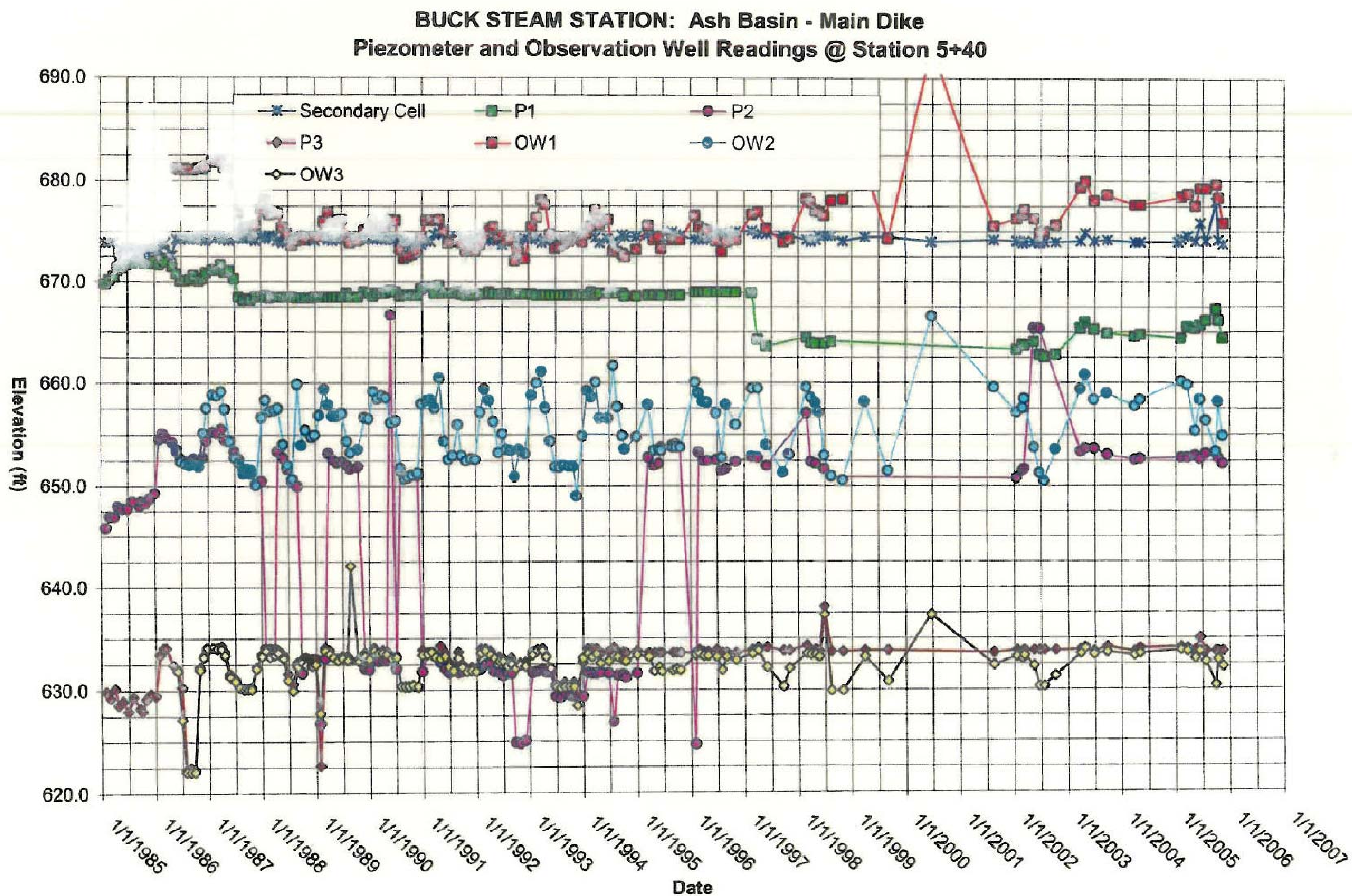
3.5 Operations & Maintenance

Buck Steam Station staff make monthly inspections and piezometer readings at the new dike, the main dike, the diverter dike and on the Basin 2 to Basin 3 outlet dam. Duke Energy has a monthly visual inspection of the dike conditions by an internal qualified individual, and an annual inspection performed internally or by an outside consultant. And, in accordance with NCUC requirements, an independent third party inspection is made every five years. The next five year inspection is due in 2010. Normal maintenance operations include mowing the grass on the dikes twice a year.

3.5.1 Settlement Point Readings for the New Dike

The 2008 Independent Inspection report prepared by S&ME, Inc. provided observations based on the settlement point reading from 1985, 1989, 2006 and 2007. A summary is provided below:

- The general rate of settlement of the points appears to be consistent when compared among the points monitored with the exception of one point, Point 7.
- Point 7 experienced an increase in the apparent rate of settlement from 2006 until 2007, settling 0.01' in a single year. In comparison, Point 7 settled 0.02' from 1985 to 1989 and 0.05' from 1989 to 2006.
- Survey error was mentioned to be a possible cause of the apparent increase in rate of settlement.
- The report recommended that the settlement points be monitored on a regular annual basis.



B-12

Drawing Copyright © 2007 CHA

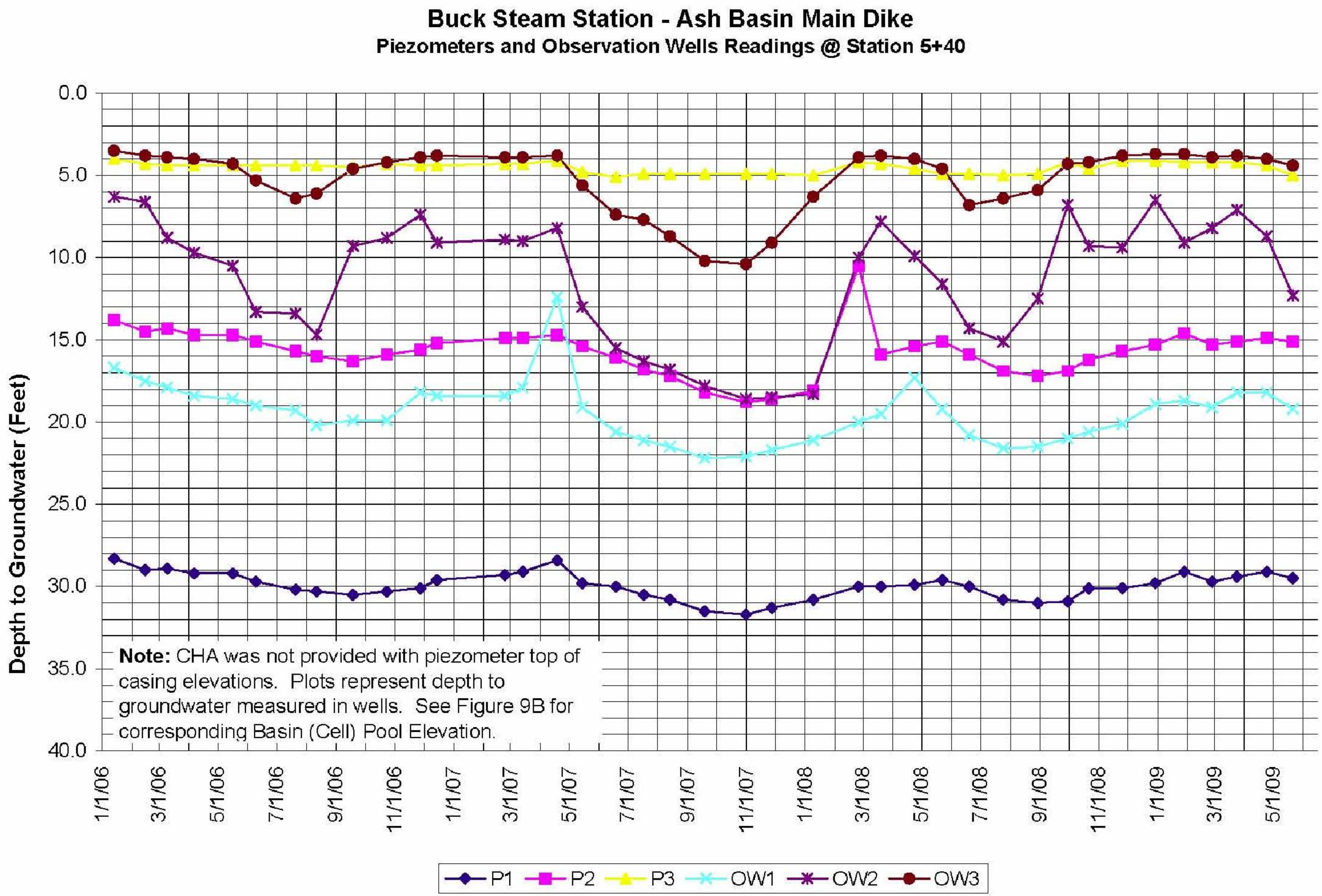
CHA

PIEZOMETER READINGS
BUCK STEAM STATION
DUKE ENERGY
SPENCER, NORTH CAROLINA

PROJECT NO. 20085.5000

DATE: JULY 2009

FIGURE 8A-1



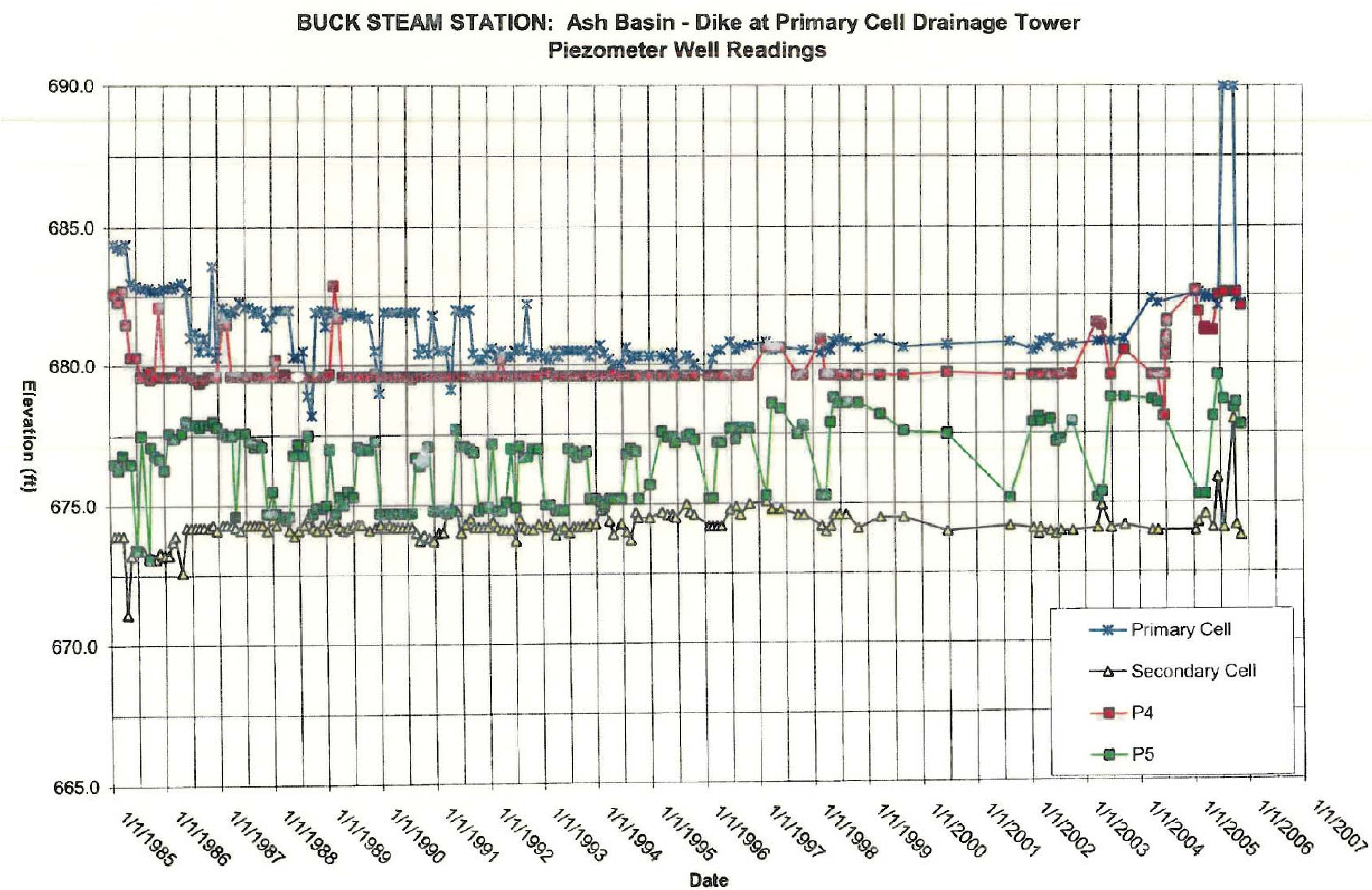
PIEZOMETER READINGS
BUCK STEAM STATION
DUKE ENERGY
SPENCER, NORTH CAROLINA

PROJECT NO. 20085.5000

DATE: JULY 2009

FIGURE 8A-2

File: K:\20085\CADD\ACAD\FIGURES\GEO\5000 BUCK\5000 BUCK DATA.DWG Saved: 7/13/2009 10:23:49 AM Plotted: 7/13/2009 4:11:28 PM User: Filkins, Rebecca



File: K:\20085\CADD\ACAD\FIGURES\GEO\5000 BUCK\5000 BUCK DATA.DWG Saved: 7/13/2009 10:23:49 AM Plotted: 7/13/2009 3:58:11 PM User: Filkins, Rebecca

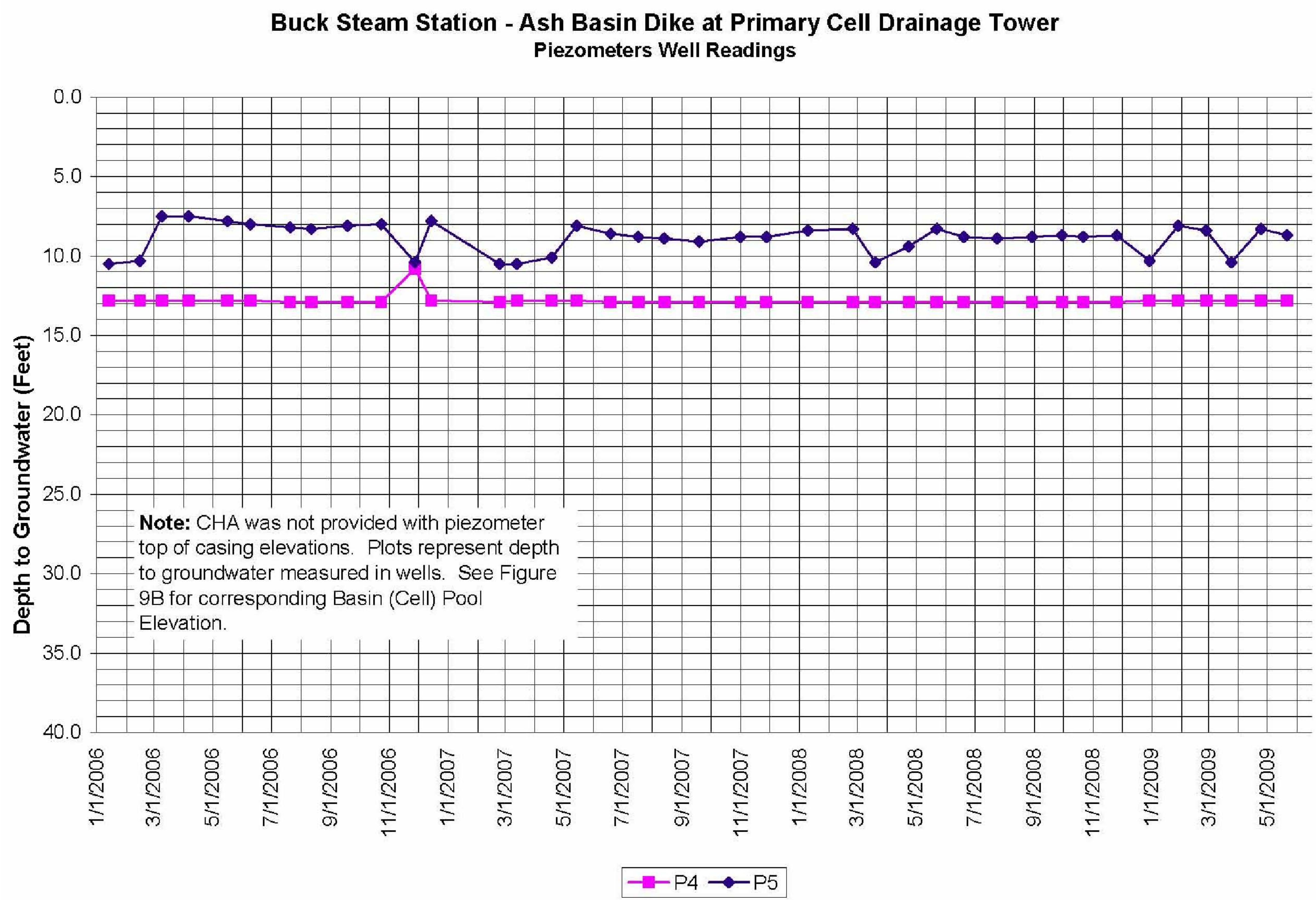
CHA

PIEZOMETER READINGS
BUCK STEAM STATION
DUKE ENERGY
SPENCER, NORTH CAROLINA

PROJECT NO. 20085.5000

DATE: JULY 2009

FIGURE 8B-1



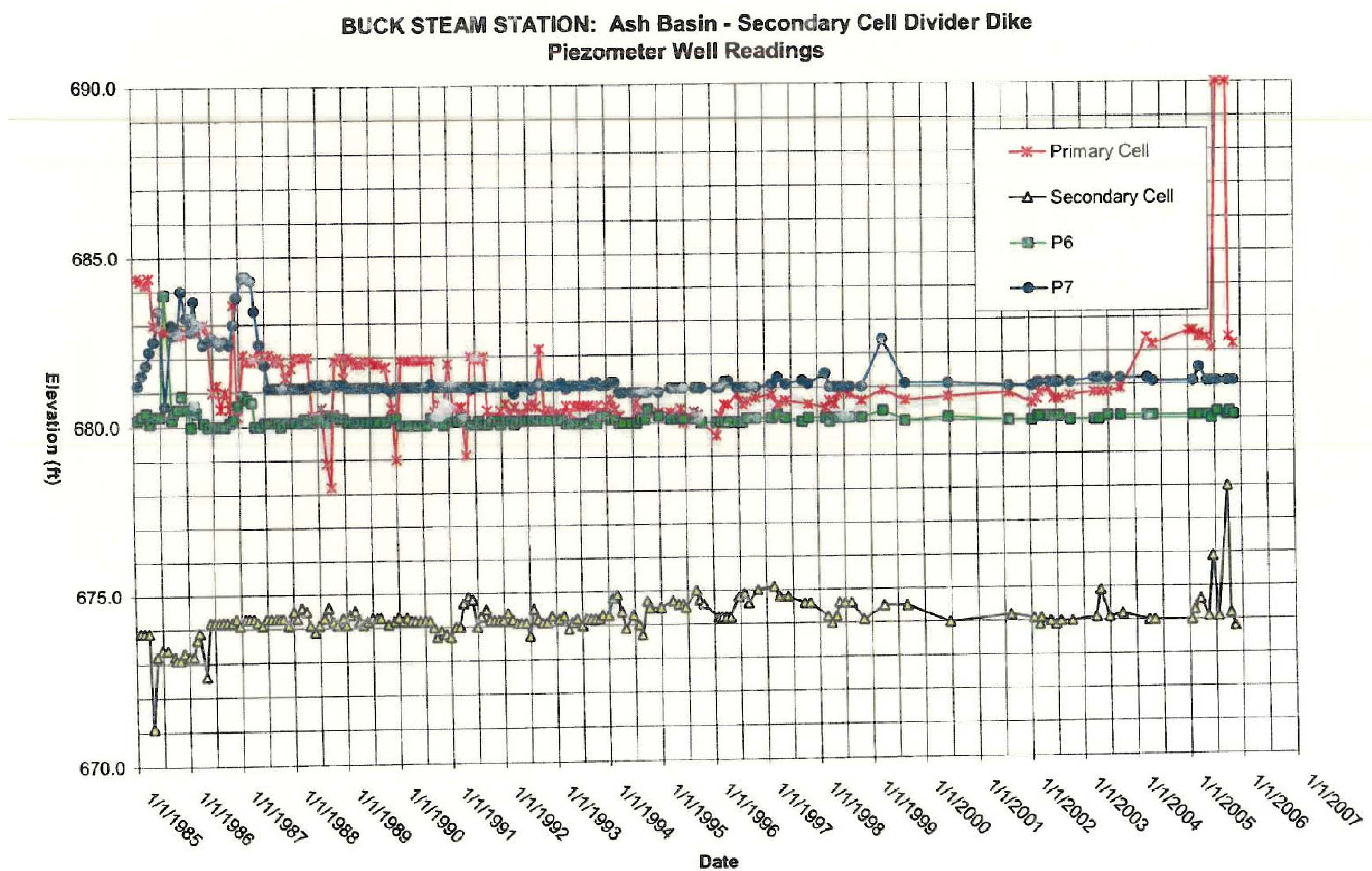
CHA

PIEZOMETER READINGS
BUCK STEAM STATION
DUKE ENERGY
SPENCER, NORTH CAROLINA

PROJECT NO. 20085.5000

DATE: JULY 2009

FIGURE 8B–2



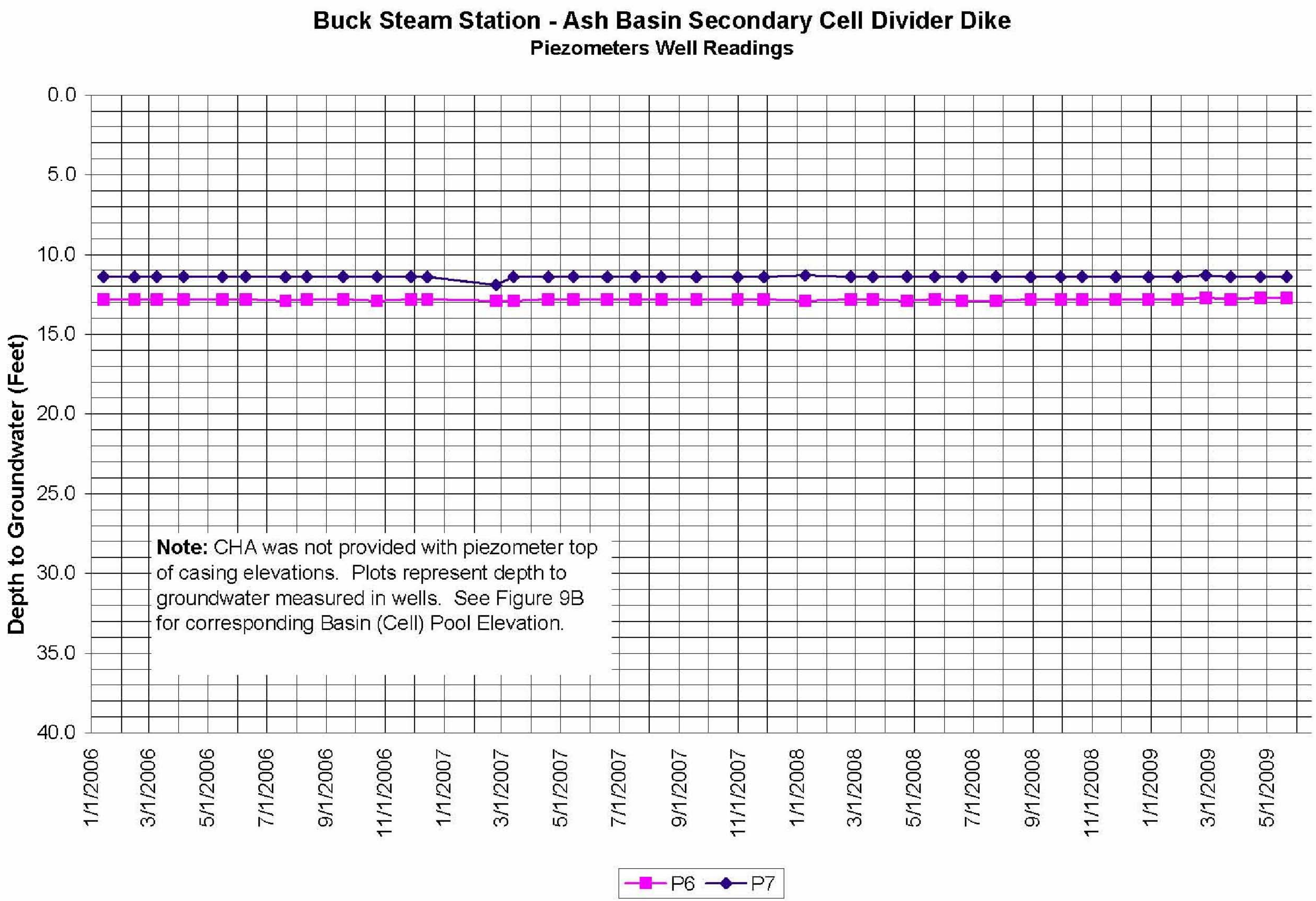
CHA

PIEZOMETER READINGS
BUCK STEAM STATION
DUKE ENERGY
SPENCER, NORTH CAROLINA

PROJECT NO. 20085.5000

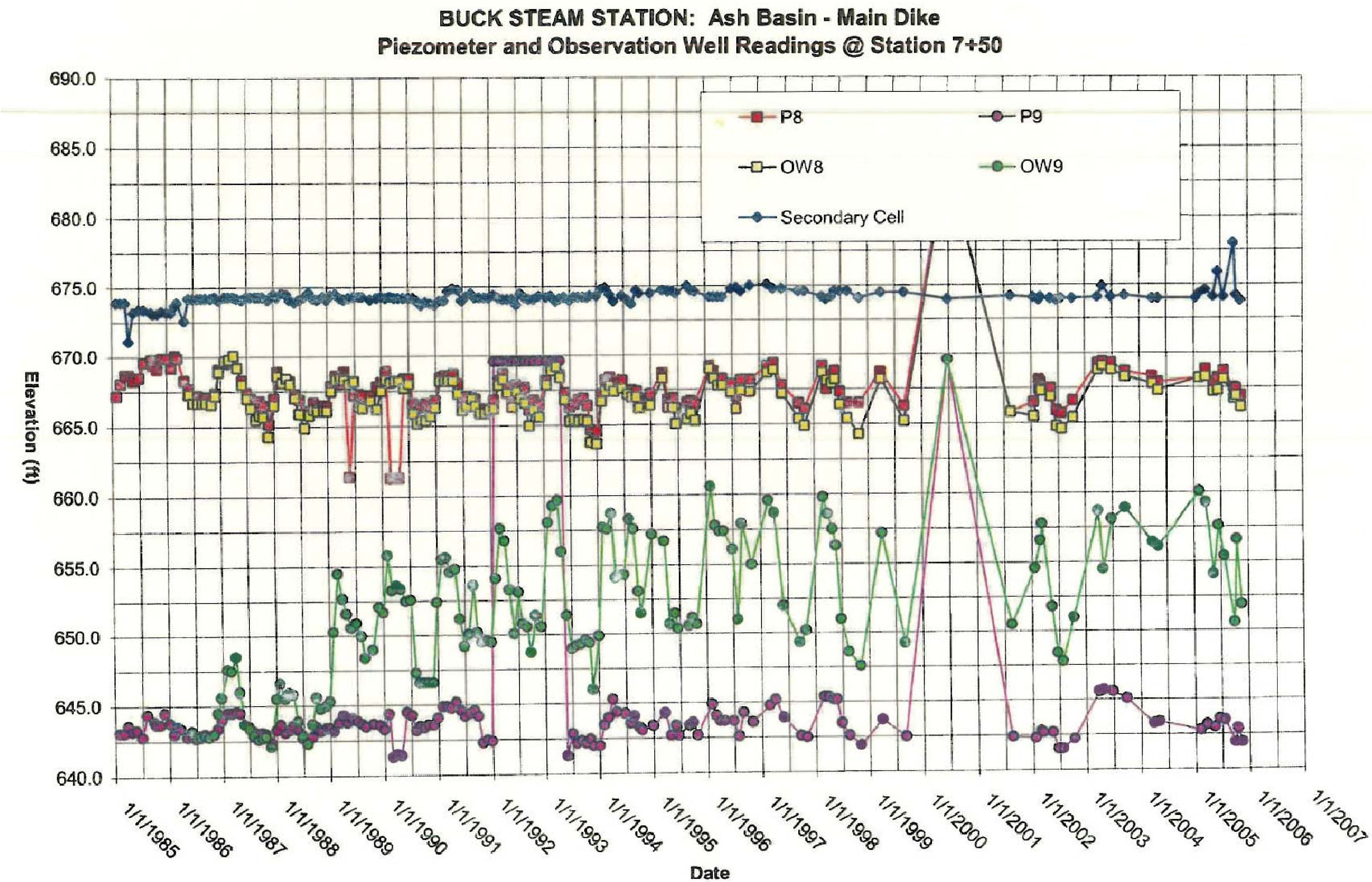
DATE: JULY 2009

FIGURE 8C–1



Drawing Copyright © 2007 CHA	PIEZOMETER READINGS BUCK STEAM STATION DUKE ENERGY SPENCER, NORTH CAROLINA	PROJECT NO. 20085.5000 DATE: JULY 2009 FIGURE 8C-2

File: K:\20085\CADD\ACAD\FIGURES\GEO\5000 BUCK\5000 BUCK DATA.DWG Saved: 7/13/2009 10:23:49 AM PLotted: 7/13/2009 4:16:39 PM User: Filkins, Rebecca



File: K:\20085\CADD\ACAD\FIGURES\GEO\5000 BUCK\5000 BUCK DATA.DWG Saved: 7/13/2009 10:23:49 AM Plotted: 7/13/2009 4:02:12 PM User: Filkins, Rebecca

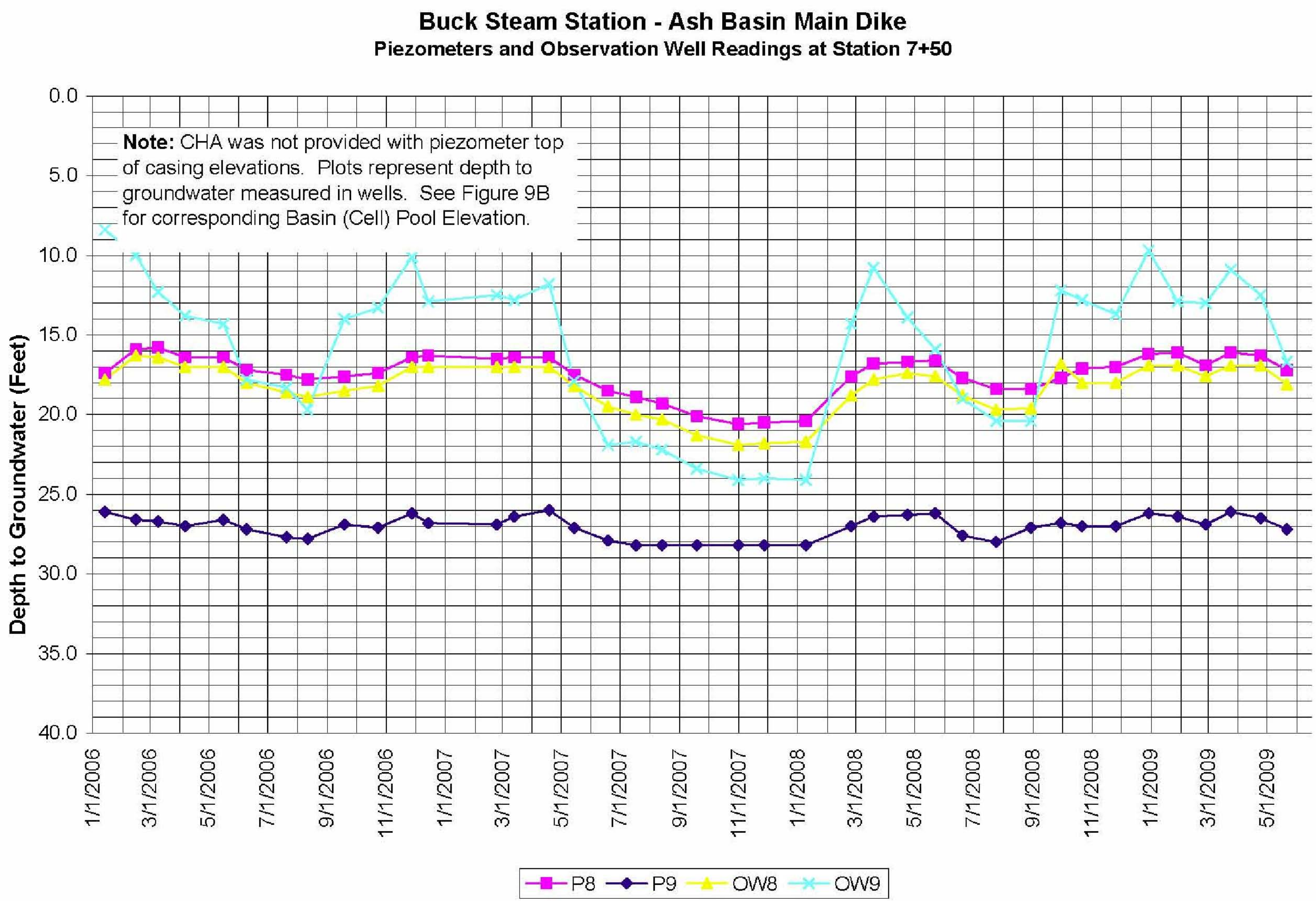
CHA

PIEZOMETER READINGS
BUCK STEAM STATION
DUKE ENERGY
SPENCER, NORTH CAROLINA

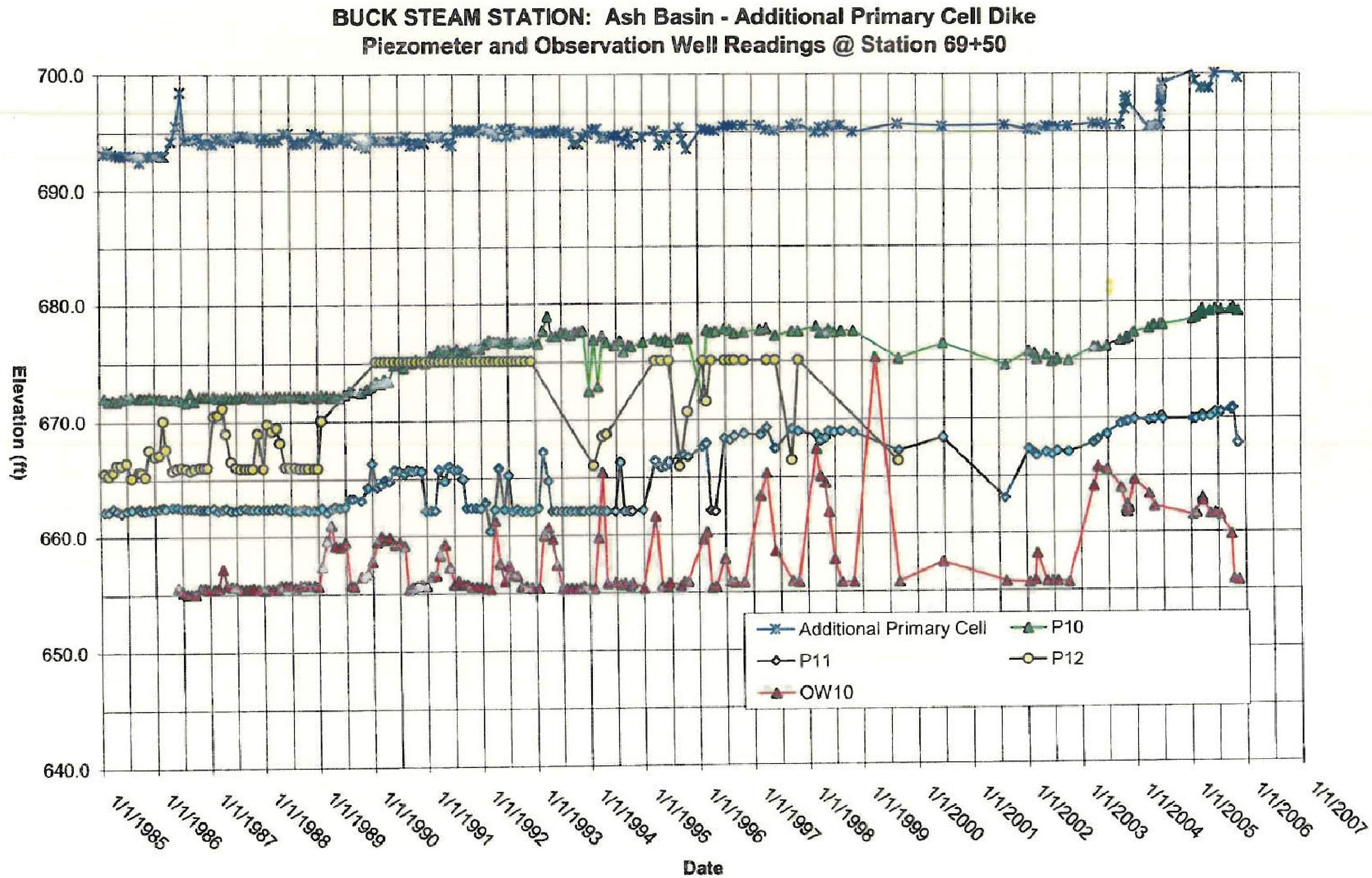
PROJECT NO. 20085.5000

DATE: JULY 2009

FIGURE 8D–1



CHA	PIEZOMETER READINGS BUCK STEAM STATION DUKE ENERGY SPENCER, NORTH CAROLINA	PROJECT NO. 20085.5000 DATE: JULY 2009 FIGURE 8D-2



Page 90

Drawing Copyright © 2007 CHA

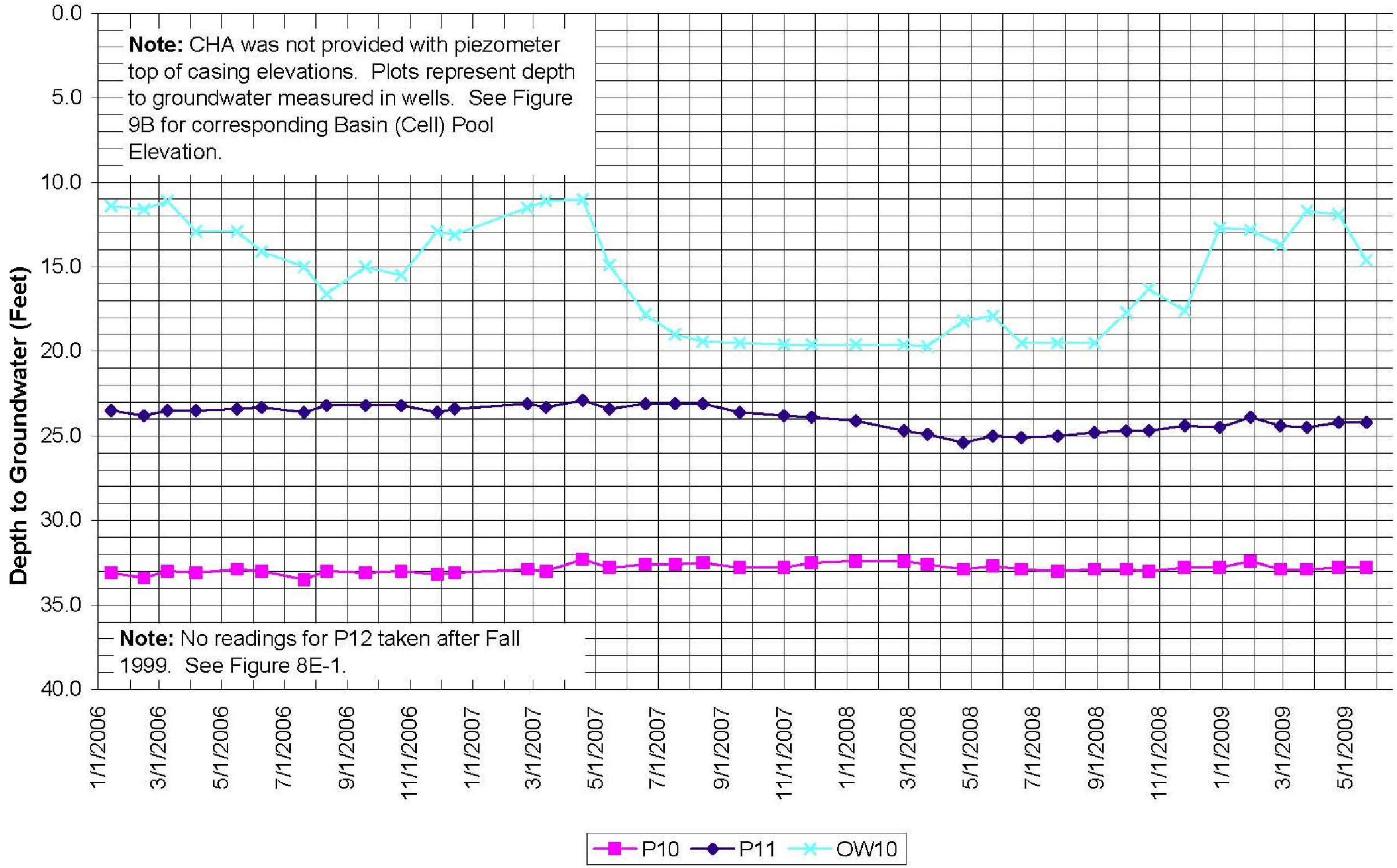
PIEZOMETER READINGS
BUCK STEAM STATION
DUKE ENERGY
SPENCER, NORTH CAROLINA

PROJECT NO. 20085.5000

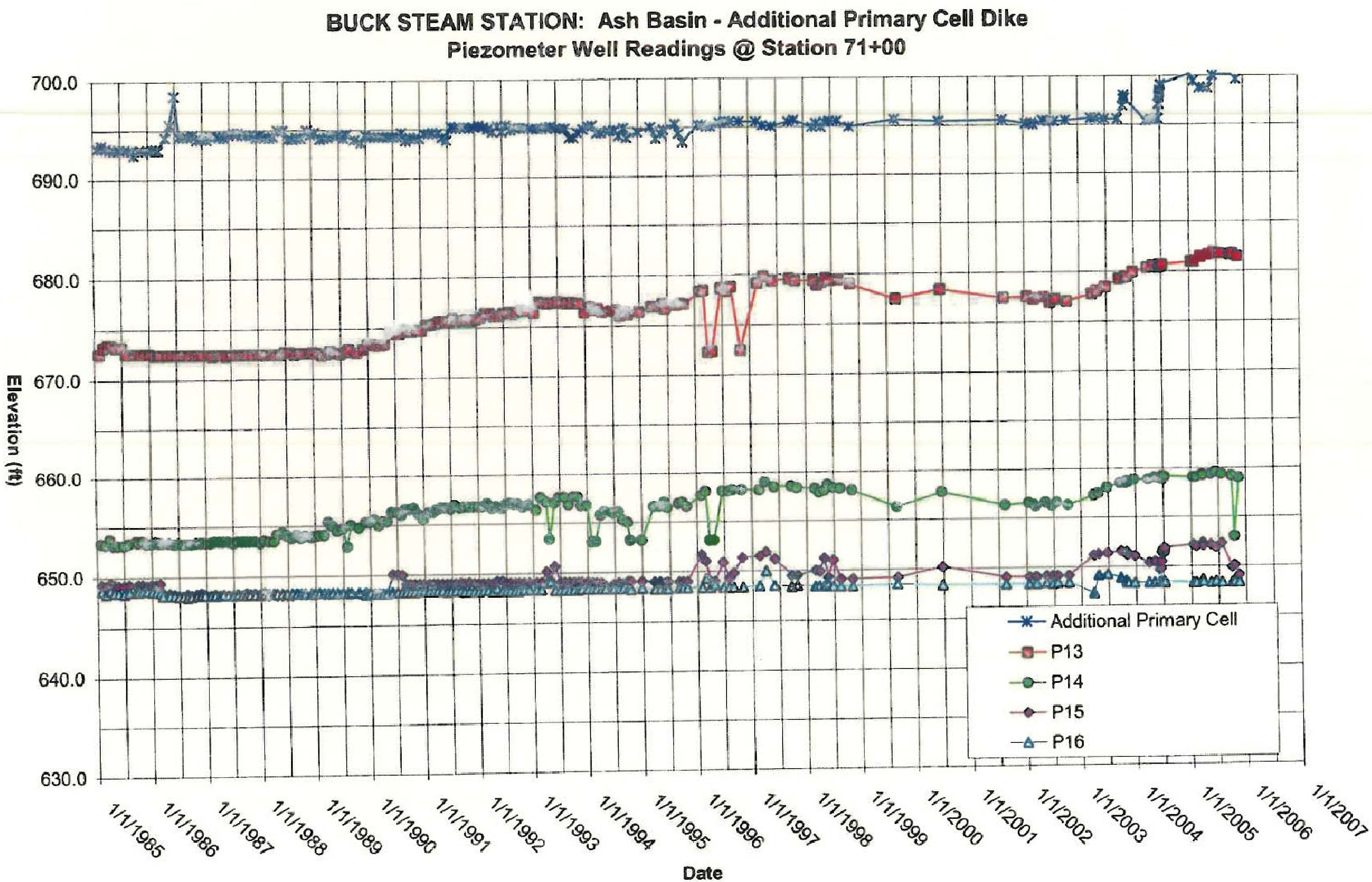
DATE: JULY 2009

FIGURE 8E-1

Buck Steam Station - Ash Basin Additional Primary Cell Dike
Piezometers and Observation Well Readings at Station 69+50



Drawing Copyright © 2007 CHA CHA	PIEZOMETER READINGS BUCK STEAM STATION DUKE ENERGY SPENCER, NORTH CAROLINA	PROJECT NO. 20085.5000 DATE: JULY 2009 FIGURE 8E-2



CHA

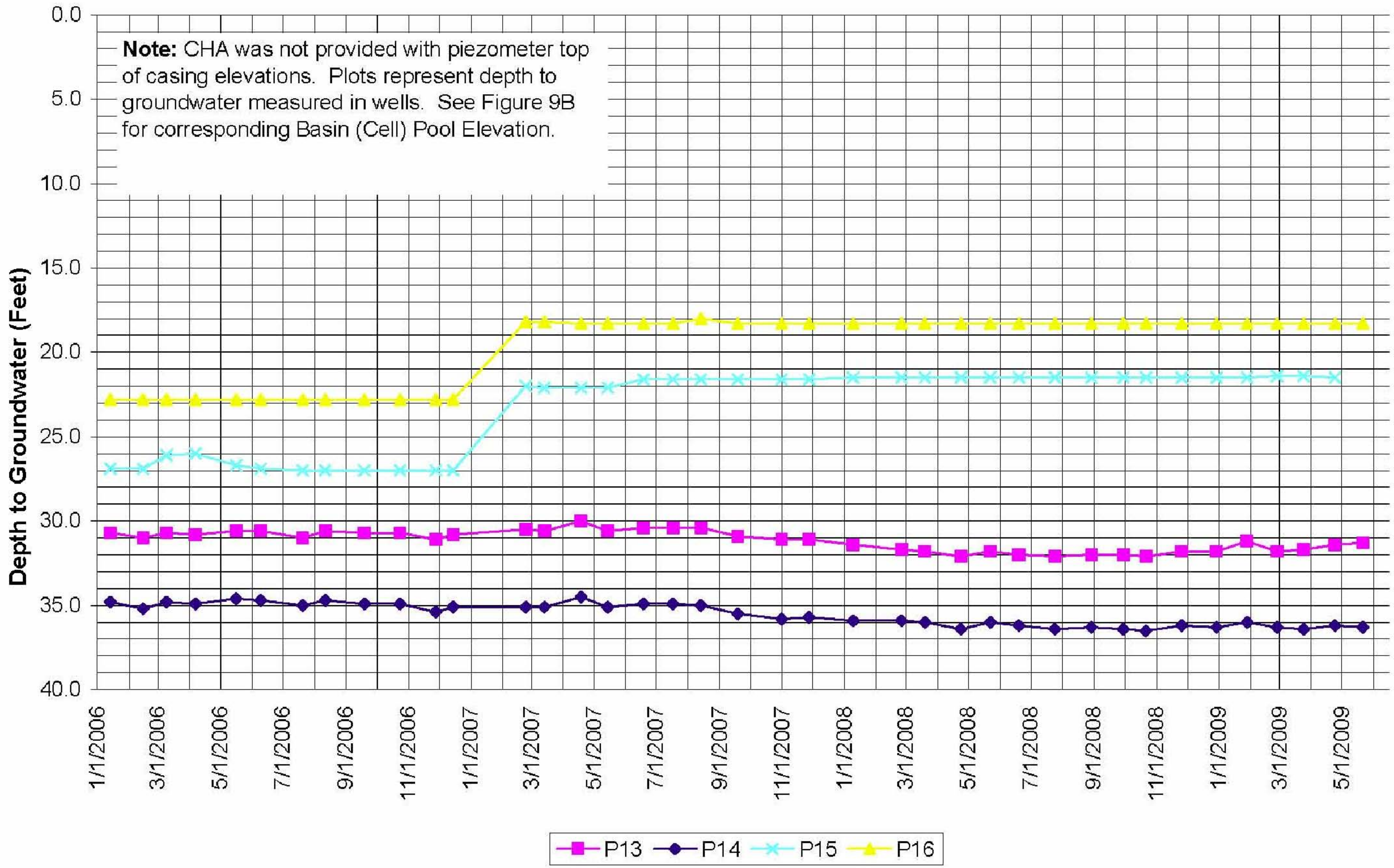
PIEZOMETER READINGS
BUCK STEAM STATION
DUKE ENERGY
SPENCER, NORTH CAROLINA

PROJECT NO.
20085.5000

DATE: JULY 2009

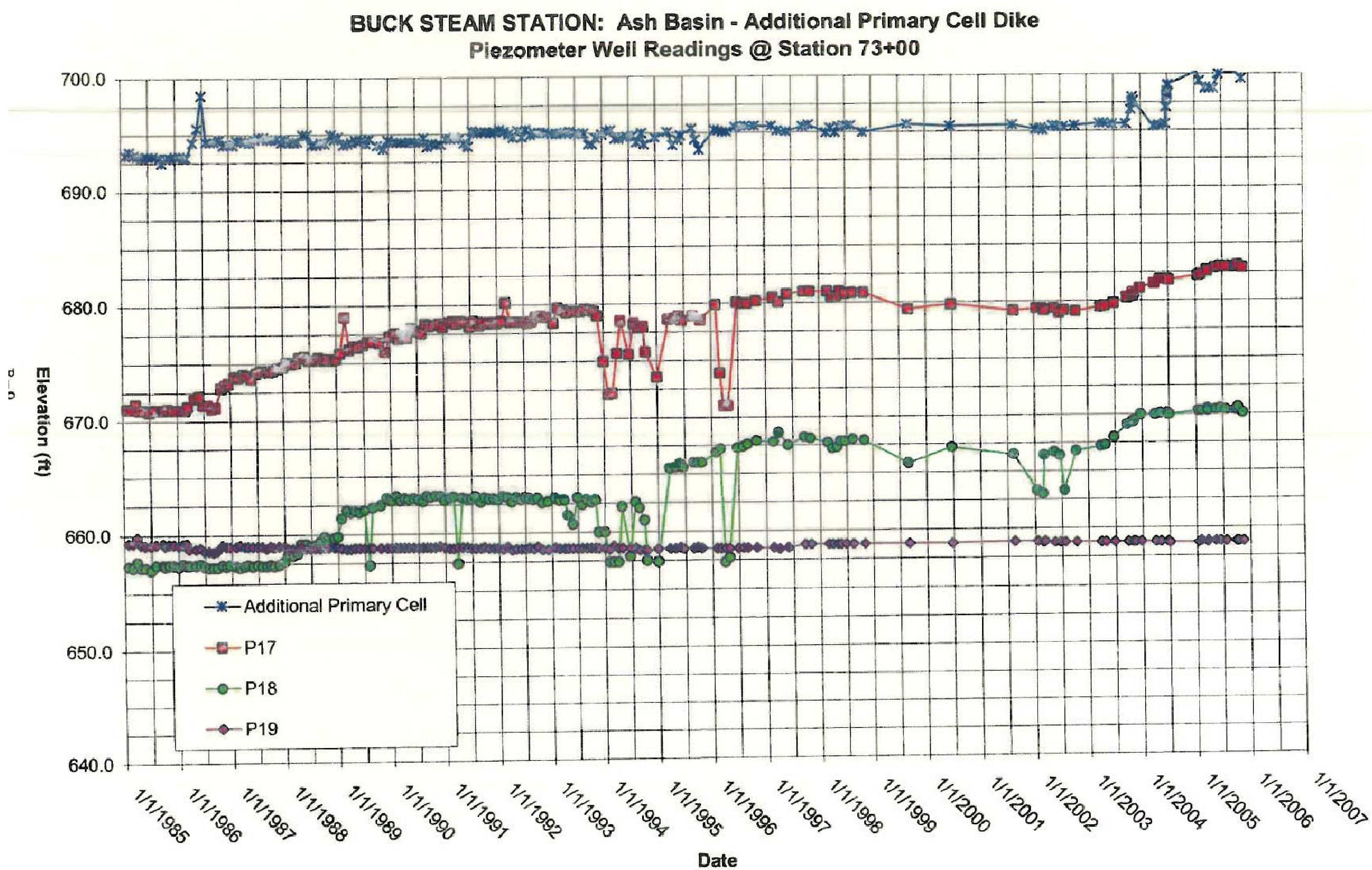
FIGURE 8F-1

Buck Steam Station - Ash Basin Additional Primary Cell Dike
Piezometers Well Readings at Station 71+00



File: K:\20085\CADD\ACAD\FIGURES\GEO\5000 BUCK\5000 BUCK DATA.DWG Saved: 7/13/2009 10:23:49 AM Plotted: 7/13/2009 4:23:01 PM User: Filkins, Rebecca

CHA	PIEZOMETER READINGS BUCK STEAM STATION DUKE ENERGY SPENCER, NORTH CAROLINA	PROJECT NO. 20085.5000 DATE: JULY 2009 FIGURE 8F–2



Drawing Copyright © 2007 CHA

CHA

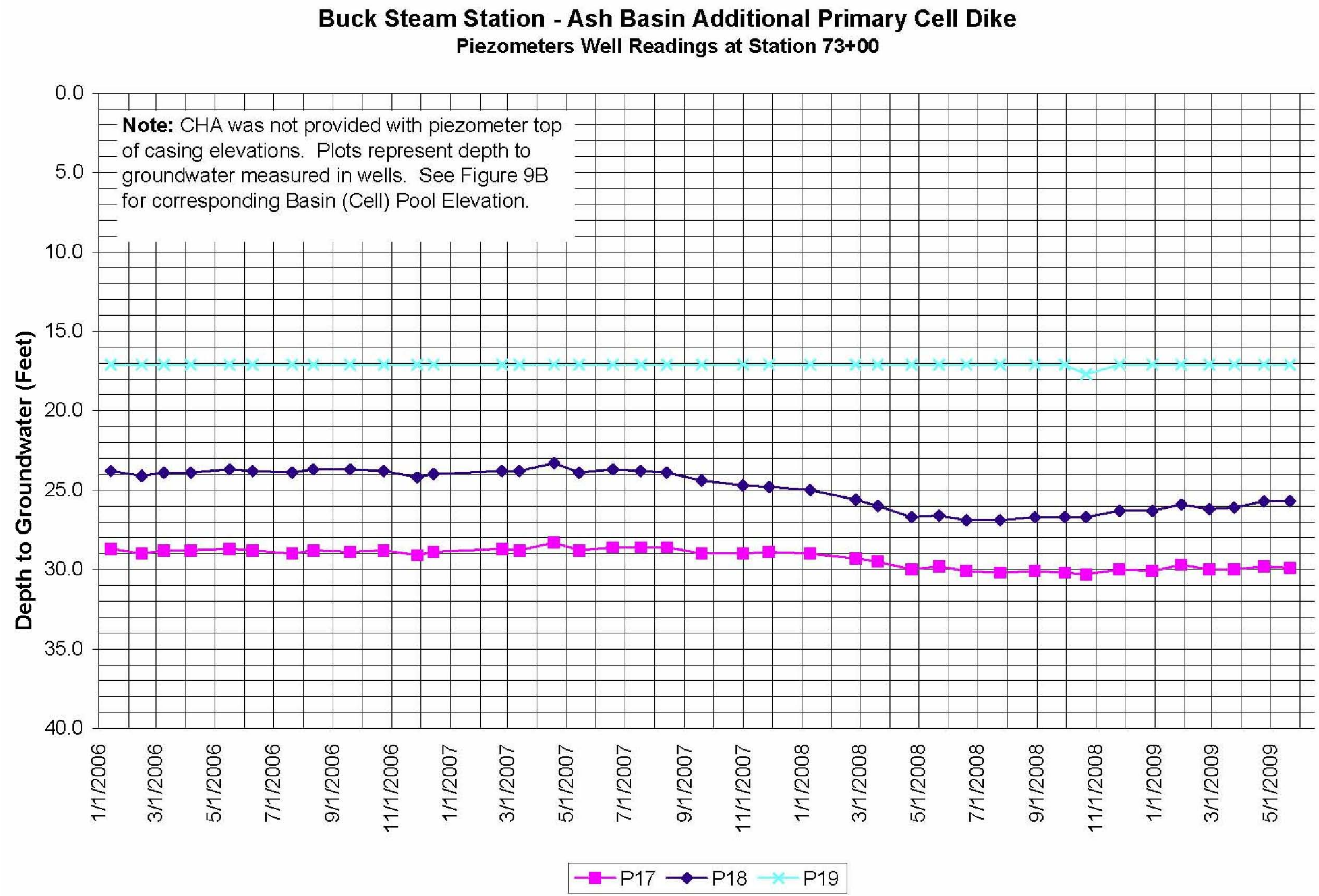
PIEZOMETER READINGS
BUCK STEAM STATION
DUKE ENERGY
SPENCER, NORTH CAROLINA

PROJECT NO. 20085.5000

DATE: JULY 2009

FIGURE 8G-1

File: K:\20085\CADD\ACAD\FIGURES\GEO\5000 BUCK\5000 BUCK DATA.DWG Saved: 7/13/2009 10:23:49 AM PLotted: 7/13/2009 4:08:44 PM User: Filkins, Rebecca



Drawing Copyright © 2007 CHA

CHA

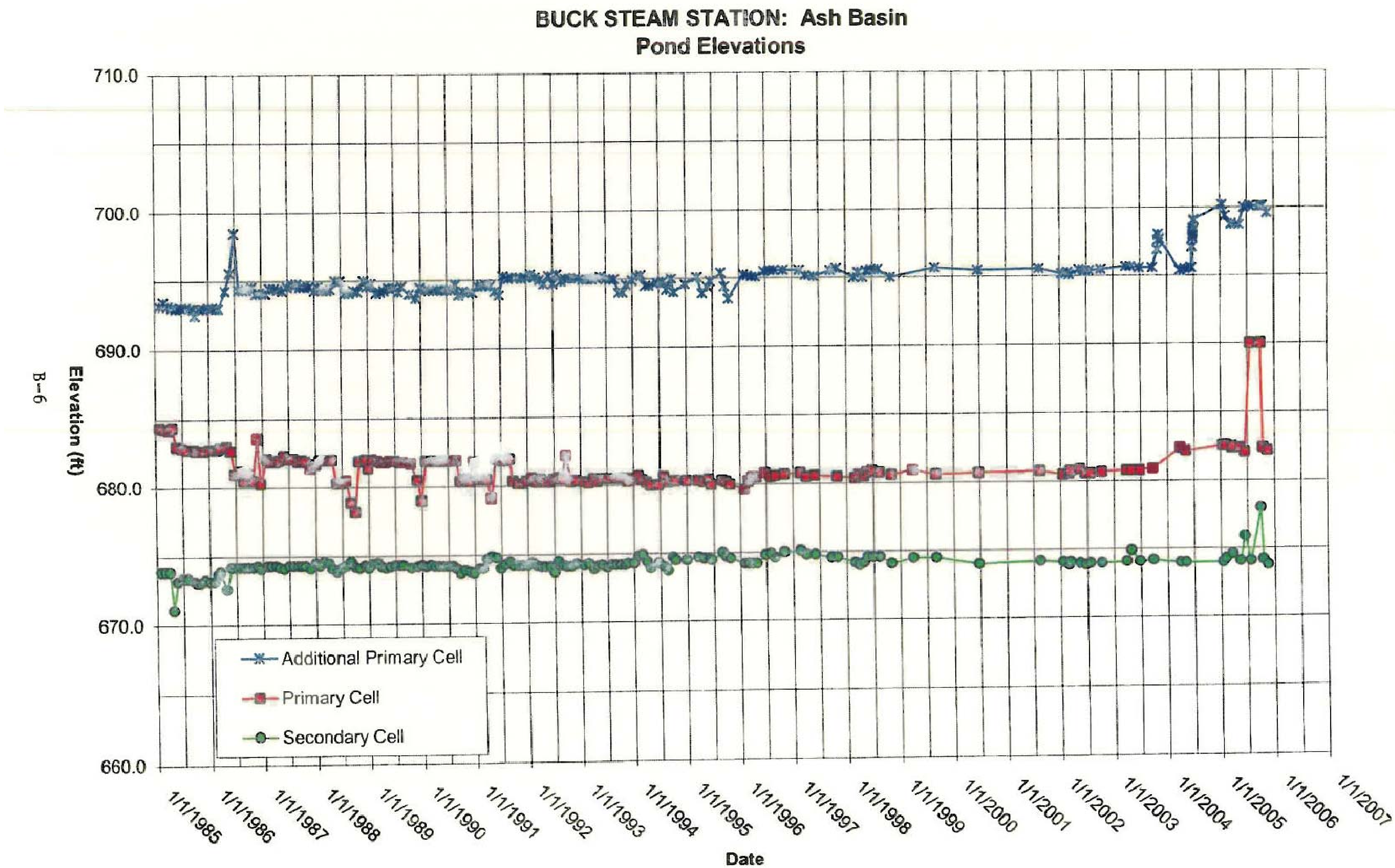
PIEZOMETER READINGS
BUCK STEAM STATION
DUKE ENERGY
SPENCER, NORTH CAROLINA

PROJECT NO. 20085.5000

DATE: JULY 2009

FIGURE 8G-2

File: K:\20085\CADD\ACAD\FIGURES\GEO\5000 BUCK\5000 BUCK DATA.DWG Saved: 7/13/2009 10:23:49 AM PLotted: 7/13/2009 4:24:54 PM User: Filkins, Rebecca

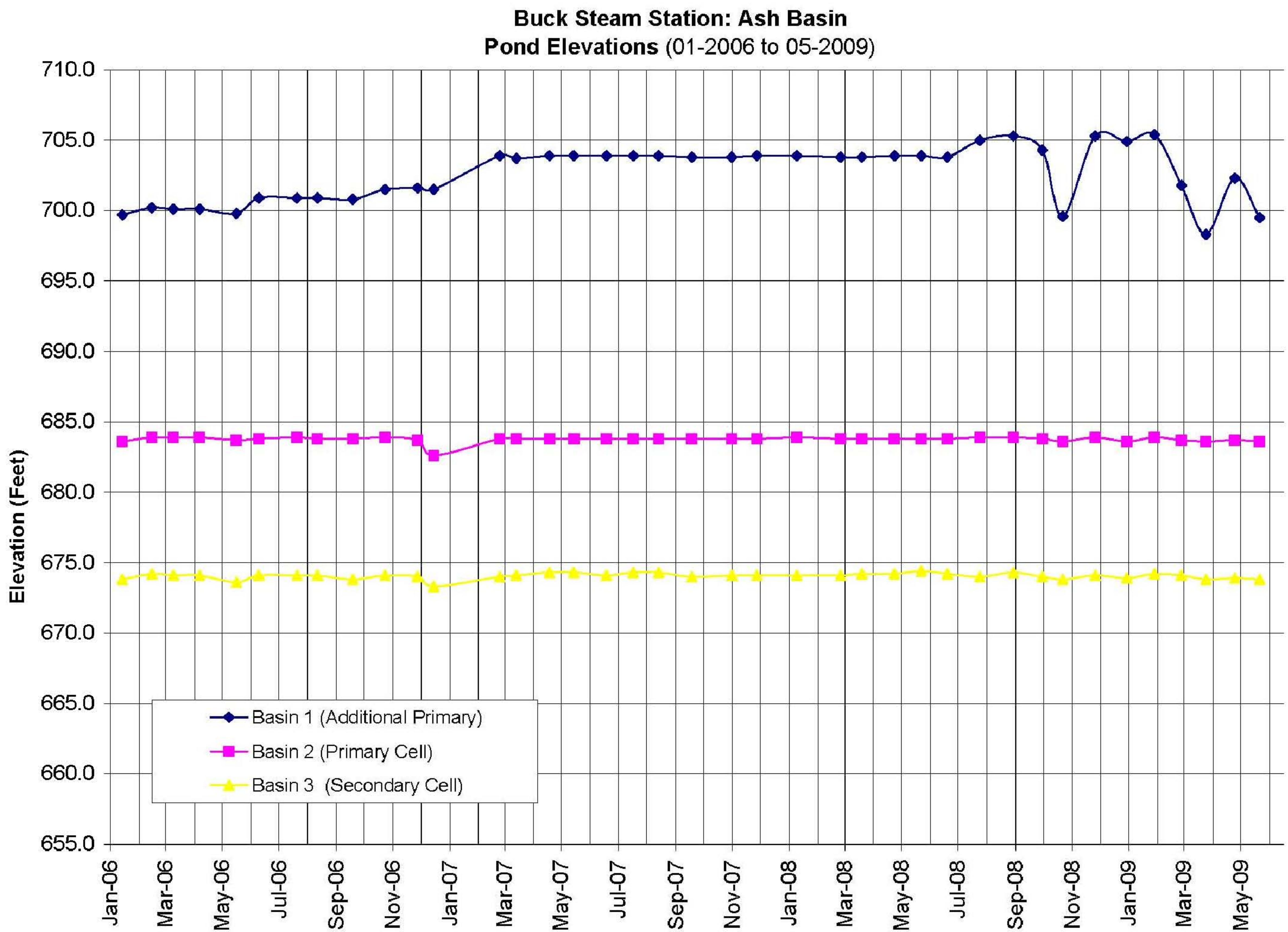


B-6

File: K:\20085\CADD\ACAD\FIGURES\GEO\5000 BUCK\5000 BUCK DATA.DWG Saved: 7/13/2009 10:23:49 AM PLotted: 7/13/2009 4:28:40 PM User: Filkins, Rebecca

CHA

POND ELEVATIONS BUCK STEAM STATION DUKE ENERGY SPENCER, NORTH CAROLINA	PROJECT NO. 20085.5000
	DATE: JULY 2009
	FIGURE 9A



CHA

POND ELEVATIONS
BUCK STEAM STATION
DUKE ENERGY
SPENCER, NORTH CAROLINA

PROJECT NO. 20085.5000

DATE: JULY 2009

FIGURE 9B

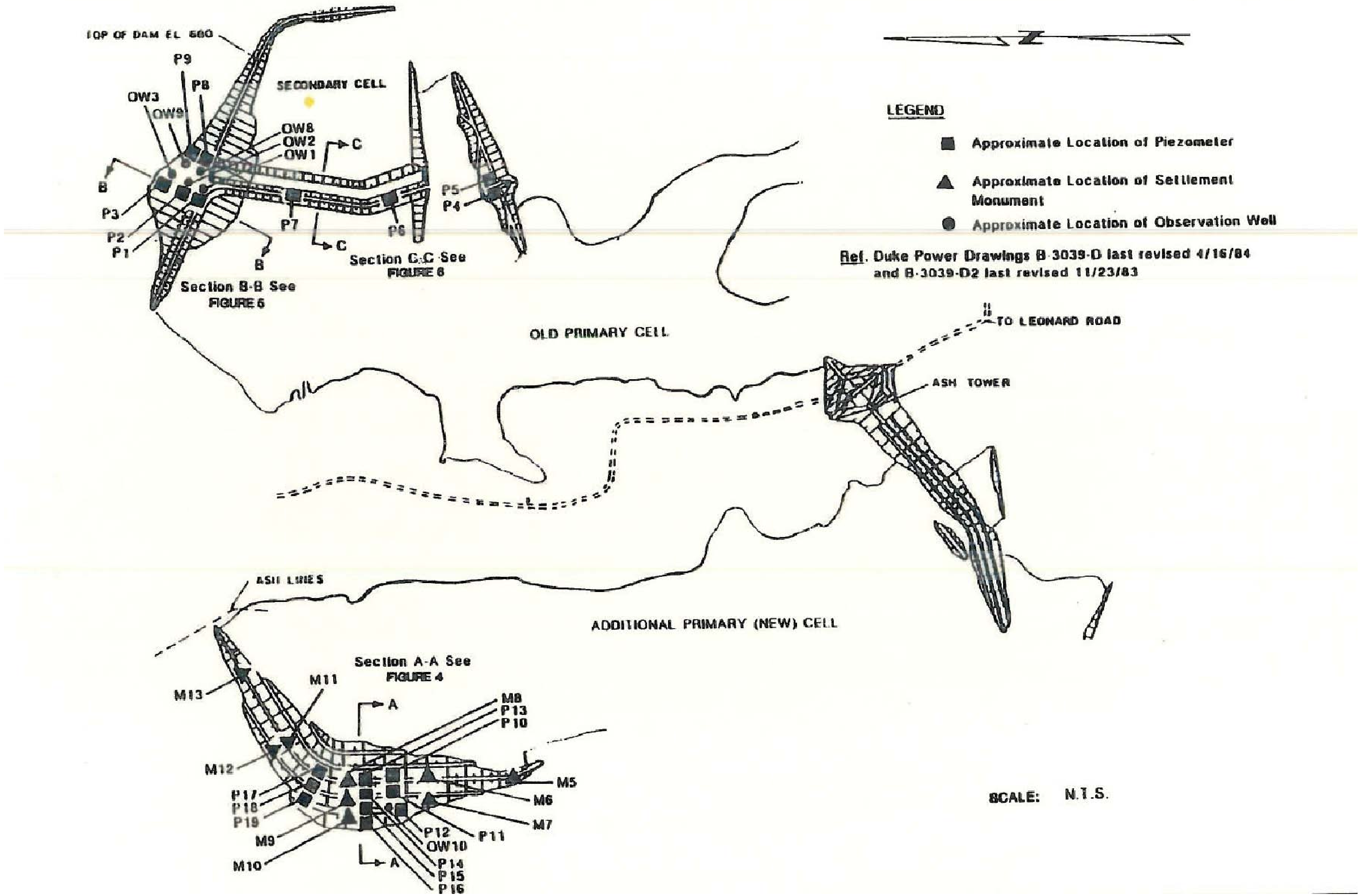


IMAGE REFERENCE: 6234-05-3350 BUCK STEAM STA.,
FIGURE 7

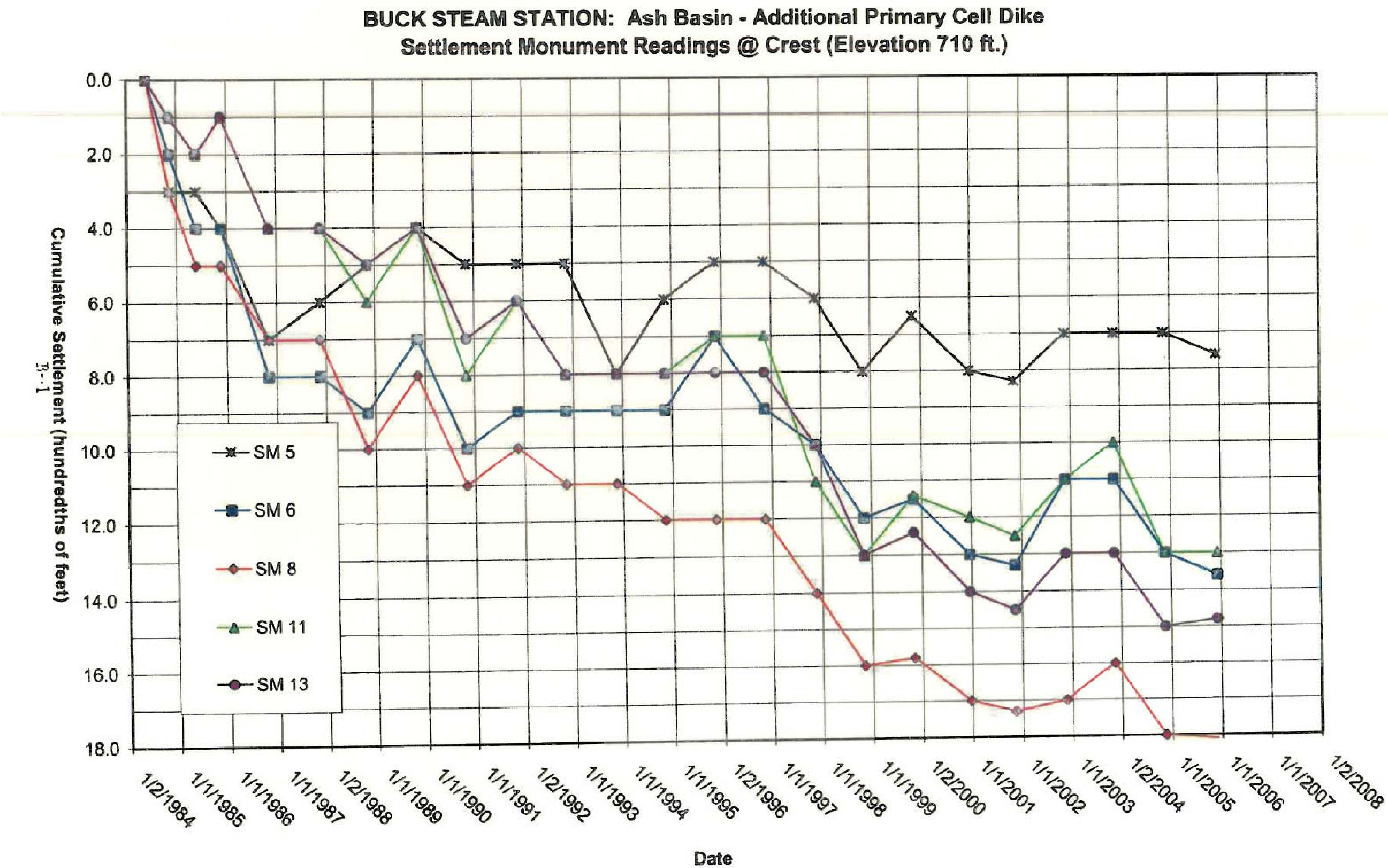
CHA

MONITORING INTRUMENTATION PLAN
BUCK STEAM STATION
DUKE ENERGY
SPENCER, NORTH CAROLINA

PROJECT NO. 20085.5000

DATE: JULY 2009

FIGURE 10



B-1

Drawing Copyright © 2007 CHA

CHA

SETTLEMENT POINT READINGS
BUCK STEAM STATION
DUKE ENERGY
SPENCER, NORTH CAROLINA

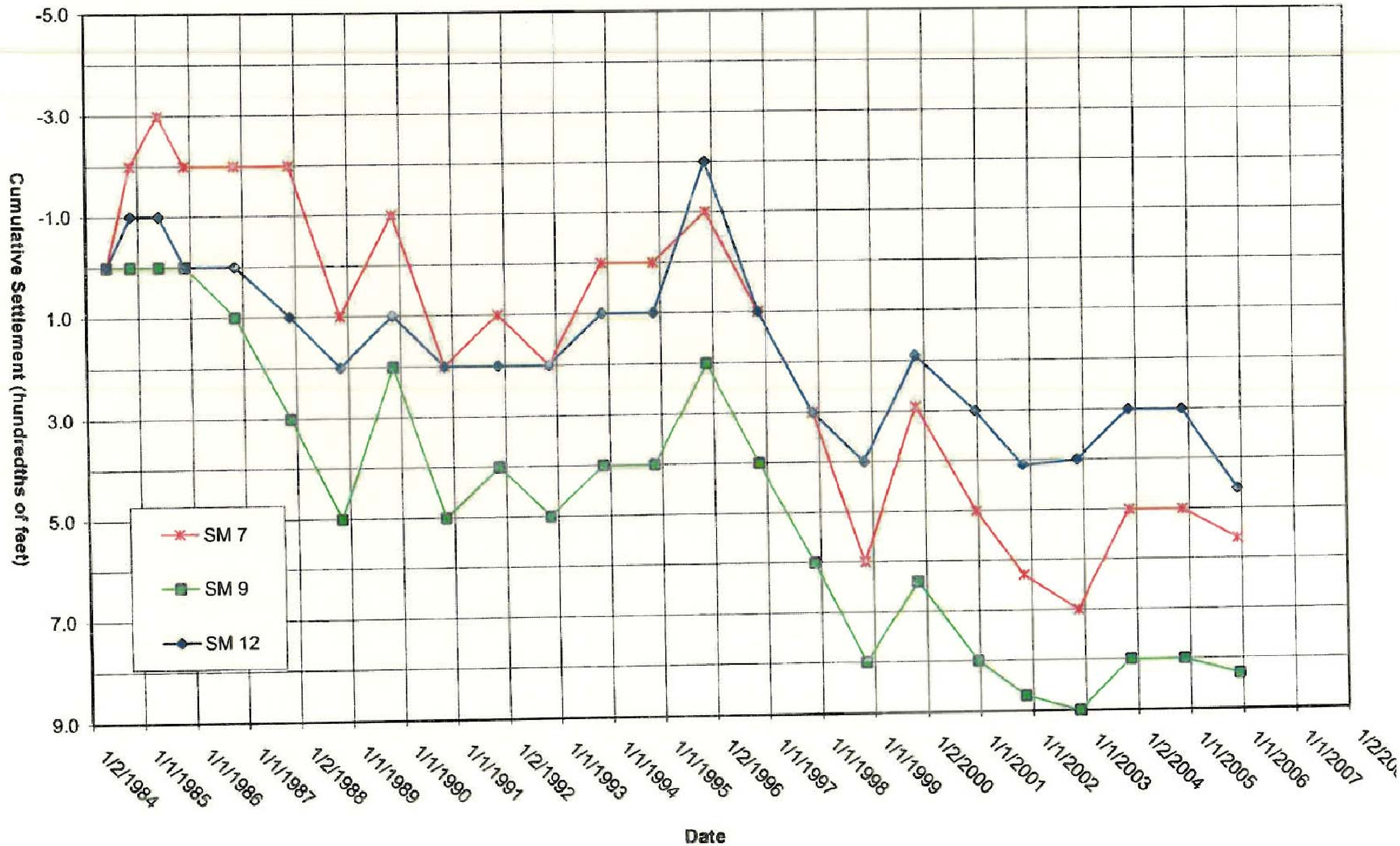
PROJECT NO. 20085.5000

DATE: JULY 2009

FIGURE 11A

File: K:\20085\CADD\ACAD\FIGURES\GEO\5000 BUCK\5000 BUCK DATA.DWG Saved: 7/13/2009 10:23:49 AM Plotted: 7/13/2009 4:36:27 PM User: Filkins, Rebecca

BUCK STEAM STATION: Ash Basin - Additional Primary Cell Dike
Settlement Monument Readings @ 690' berm



B-2

Drawing Copyright © 2007 CHA

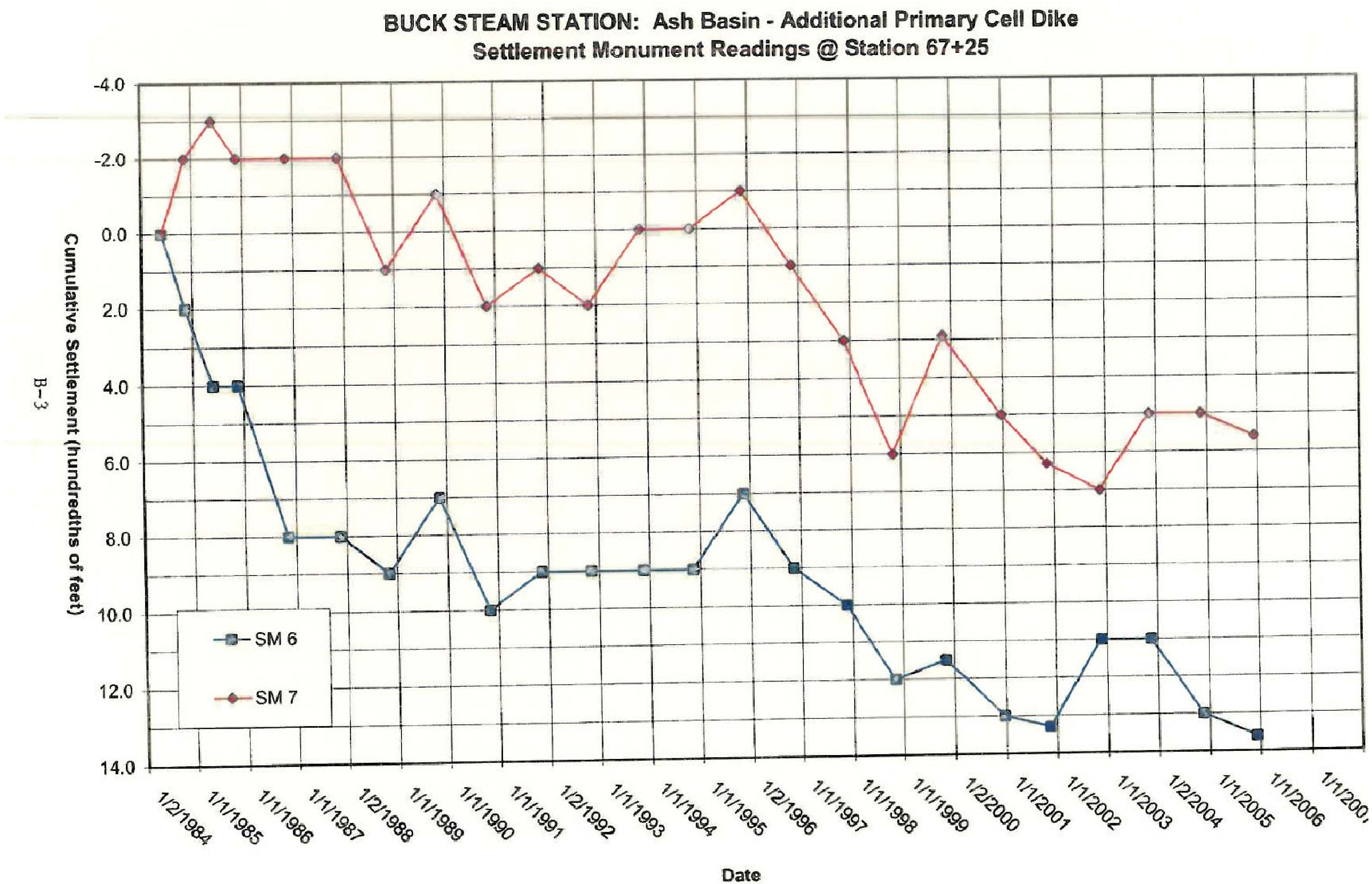
CHA

SETTLEMENT POINT READINGS
BUCK STEAM STATION
DUKE ENERGY
SPENCER, NORTH CAROLINA

PROJECT NO. 20085.5000

DATE: JULY 2009

FIGURE 11B



B-3

Drawing Copyright © 2007 CHA

CHA

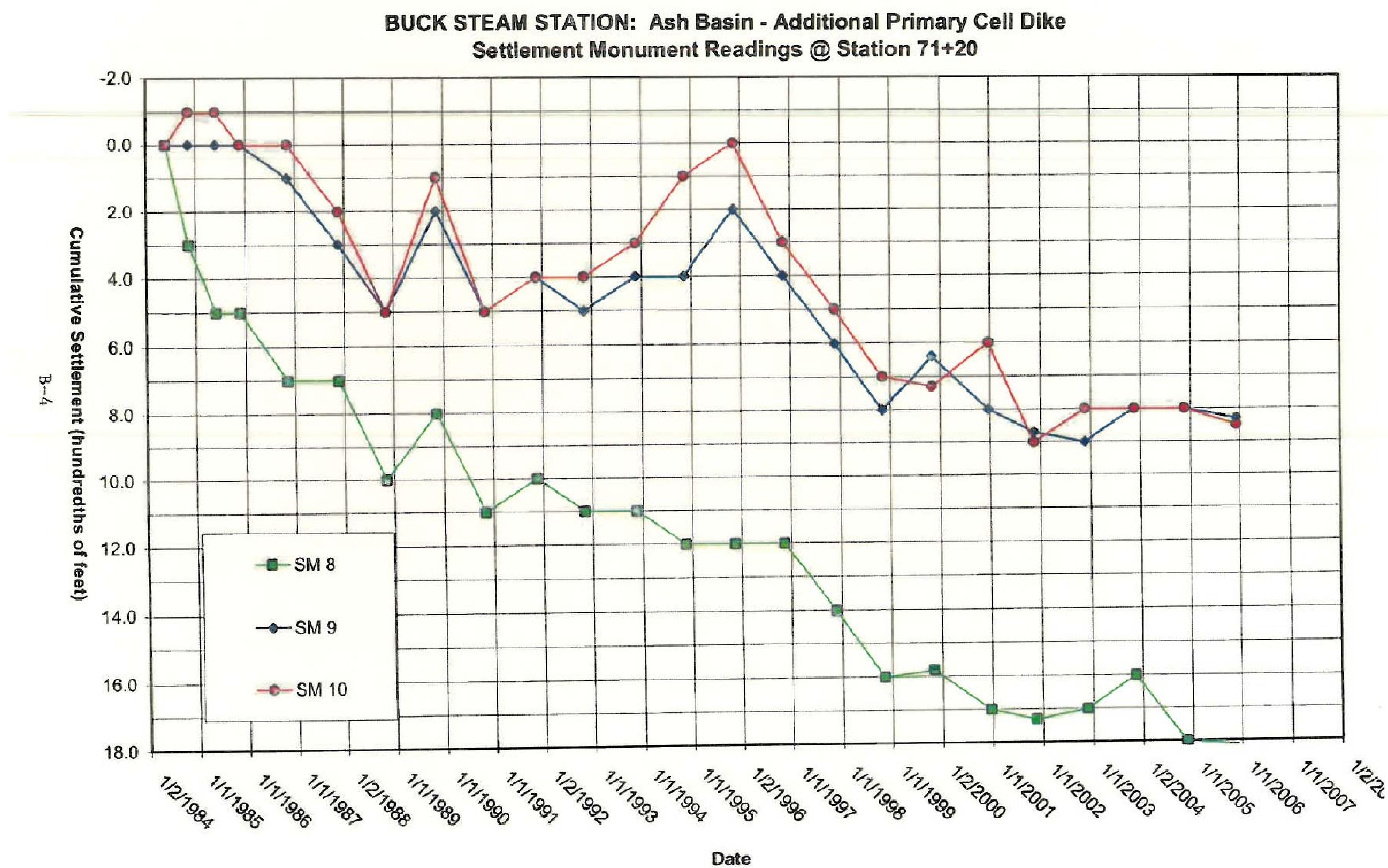
SETTLEMENT POINT READINGS
BUCK STEAM STATION
DUKE ENERGY
SPENCER, NORTH CAROLINA

PROJECT NO. 20085.5000

DATE: JULY 2009

FIGURE 11C

File: K:\20085\CADD\ACAD\FIGURES\GEO\5000 BUCK\5000 BUCK DATA.DWG Saved: 7/13/2009 10:23:49 AM PLotted: 7/13/2009 4:43:32 PM User: Filkins, Rebecca



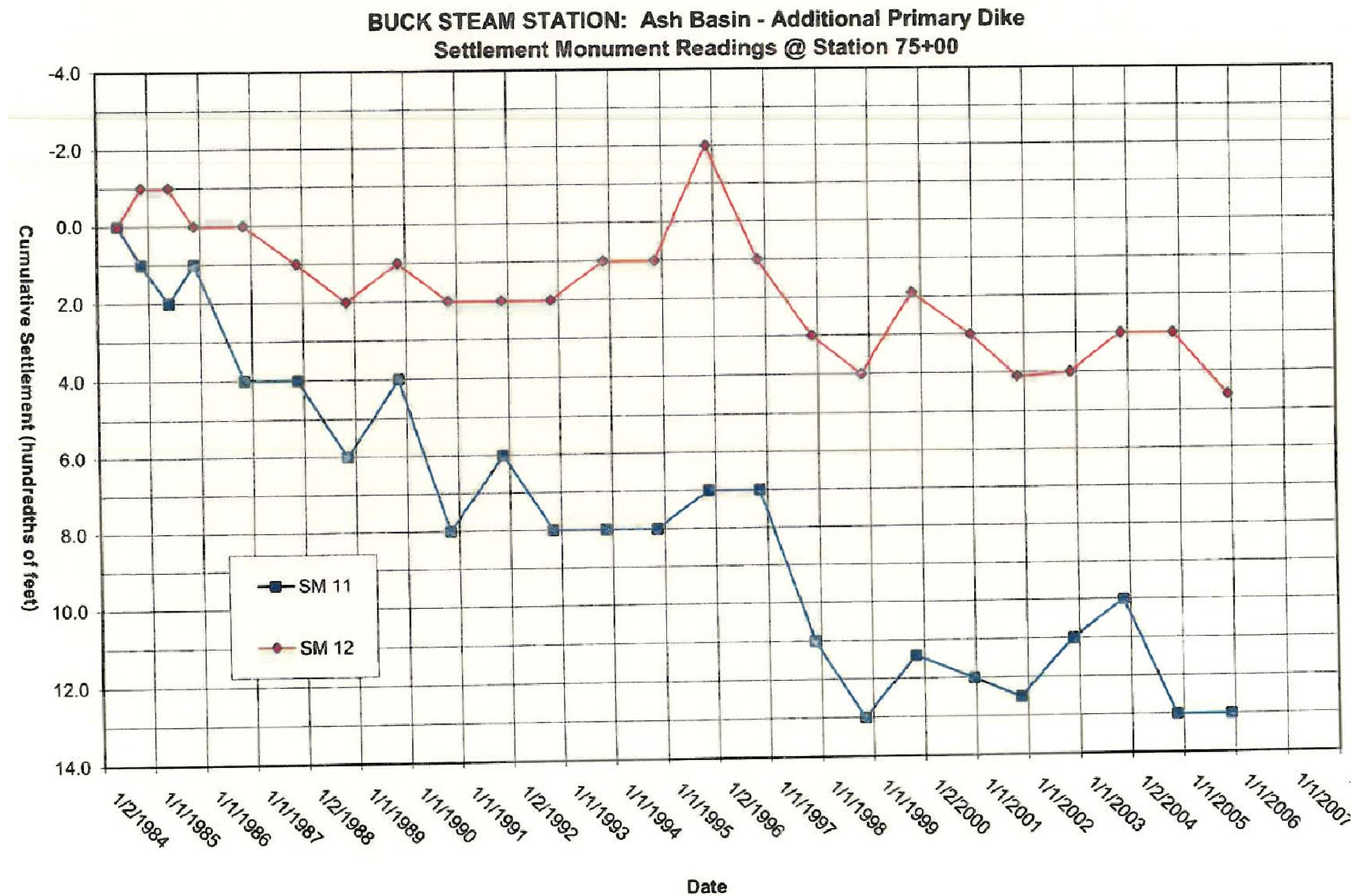
B-4

SETTLEMENT POINT READINGS
BUCK STEAM STATION
DUKE ENERGY
SPENCER, NORTH CAROLINA

PROJECT NO. 20085.5000

DATE: JULY 2009

FIGURE 11D



CHA

SETTLEMENT POINT READINGS
BUCK STEAM STATION
DUKE ENERGY
SPENCER, NORTH CAROLINA

PROJECT NO. 20085.5000

DATE: JULY 2009

FIGURE 11E

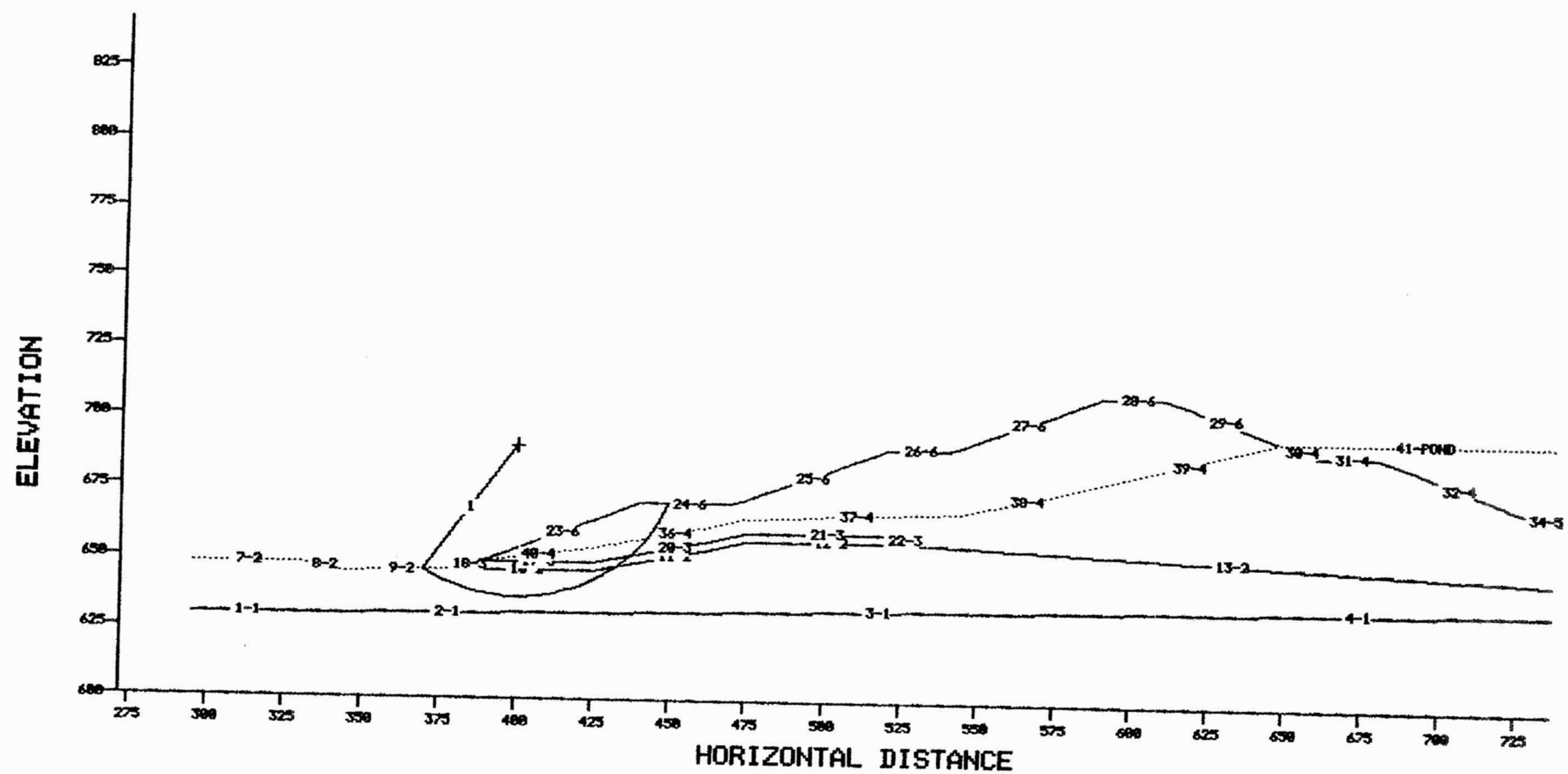
SB-SLOPE

Simplified Bishop Slope Stability Analysis

PROJECT: Steady State Seepage - piezometers P10, P11, OW10
LOCATION: Buck Steam Station
FILE: BUAP6950
PARTIAL SLOPE CROSS SECTION SHOWN

CIRCLE	X	Y	RADIUS	FS
1	400.0	690.0	53.4	1.51

SOIL*	DENSITY	COHESION	PHI
1	125.0	5000.0	40.0
2	126.0	100.0	25.0
3	125.0	0.0	35.0
4	123.0	0.0	33.0
5	120.0	0.0	32.0
6	123.0	0.0	33.0



Drawing Copyright © 2007 CHA

CHA

1996 STABILITY ANALYSIS
BUCK STEAM STATION
DUKE ENERGY
SPENCER, NORTH CAROLINA

PROJECT NO. 20085.5000
DATE: JULY 2009
FIGURE 12A

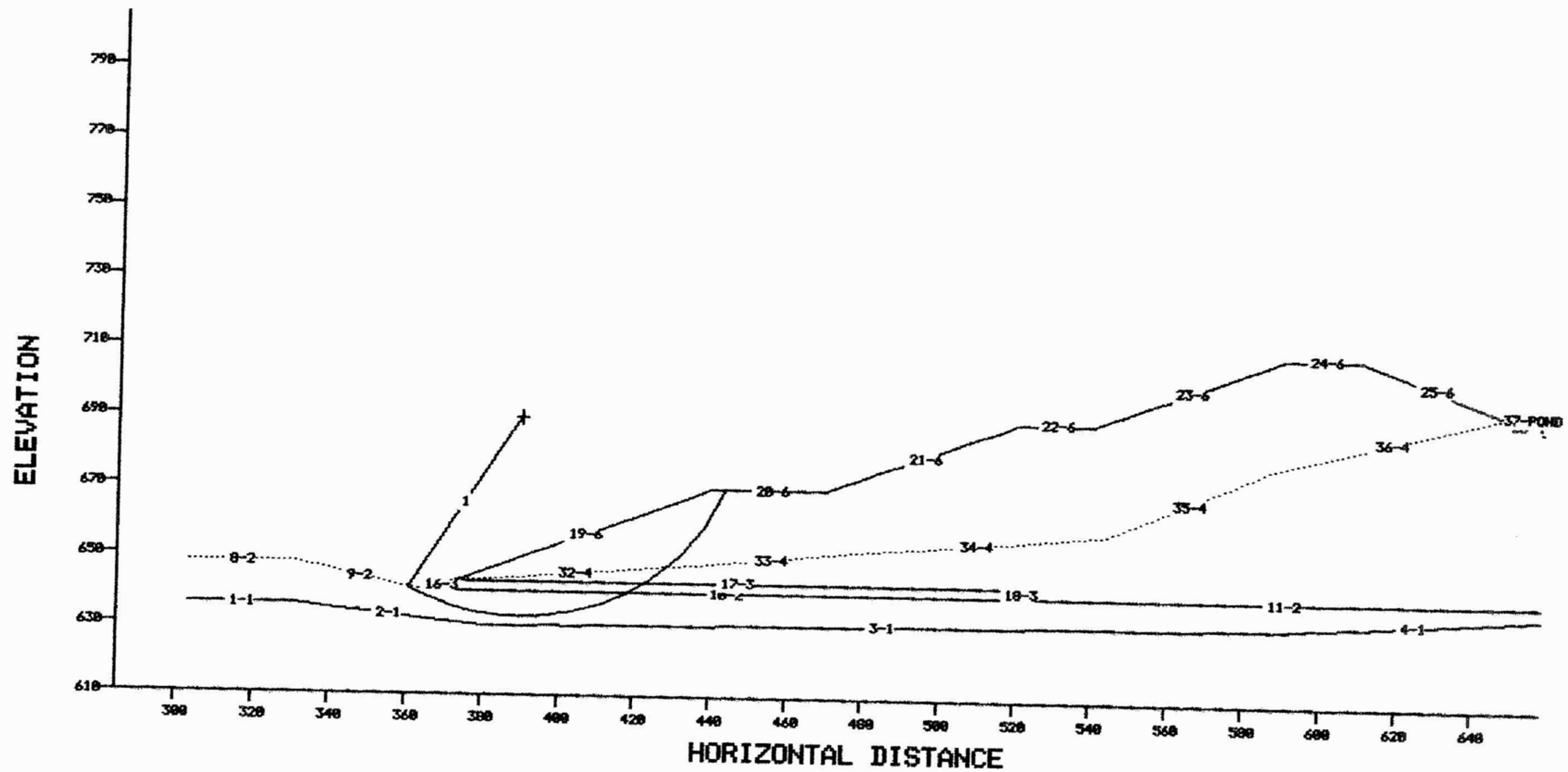
SB-SLOPE

Simplified Bishop Slope Stability Analysis

PROJECT: Steady State Seepage piezometers P13, P14, P15, P16
LOCATION: Buck Steam Station
FILE: BUAP7100
PARTIAL SLOPE CROSS SECTION SHOWN

CIRCLE	X	Y	RADIUS	FS
1	390.0	690.0	57.1	1.60

SOIL*	DENSITY	COHESION	PHI
1	125.0	5000.0	40.0
2	126.0	100.0	25.0
3	125.0	0.0	35.0
4	123.0	0.0	33.0
5	120.0	0.0	32.0
6	123.0	0.0	33.0



* Number after hyphen('-') is Soil Type

Duke Power Company - Design Engineering Department

Drawing Copyright © 2007 CHA

CHA

1996 STABILITY ANALYSIS
BUCK STEAM STATION
DUKE ENERGY
SPENCER, NORTH CAROLINA

PROJECT NO. 20085.5000

DATE: JULY 2009

FIGURE 12B

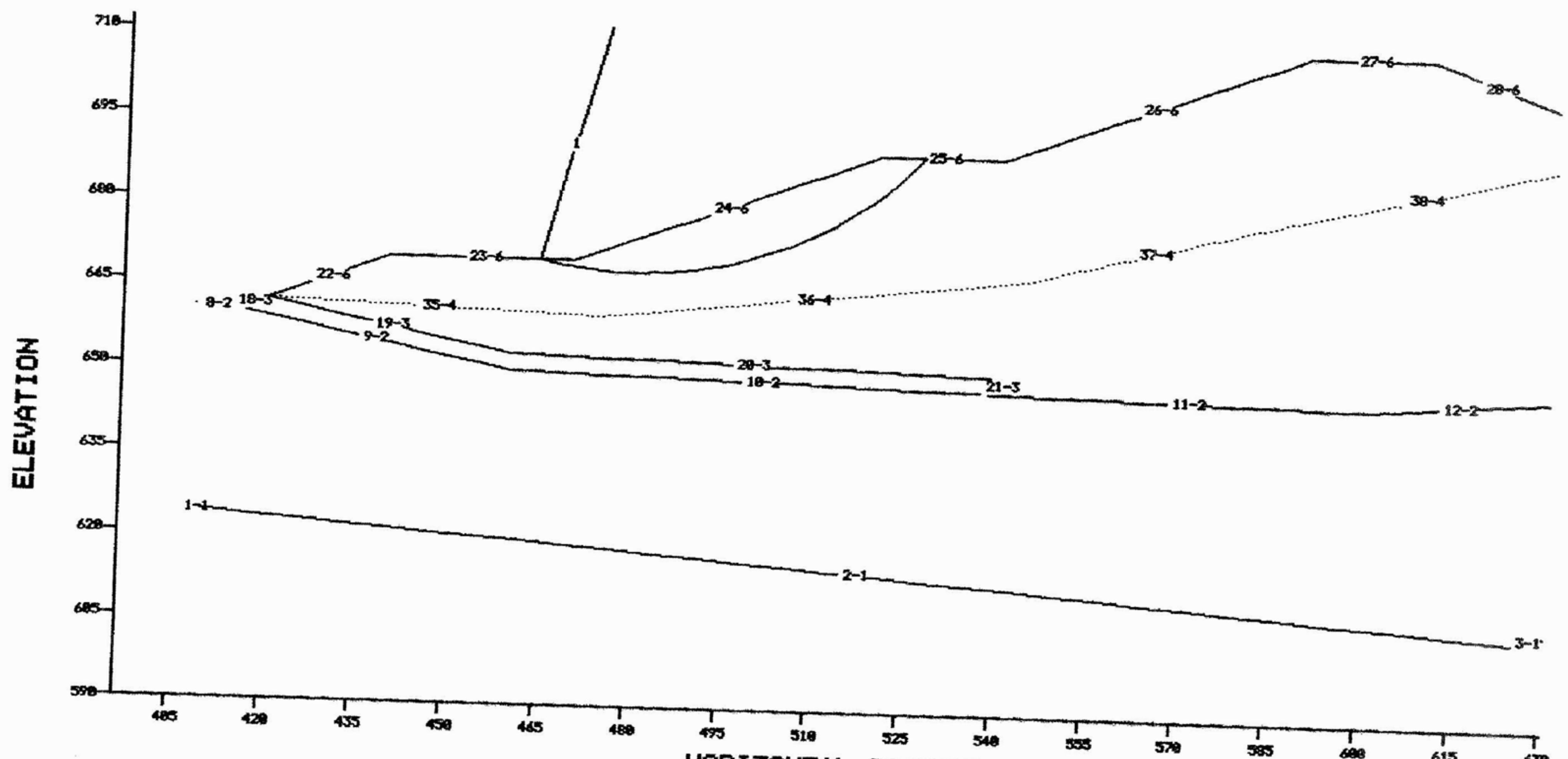
SB-SLOPE

Simplified Bishop Slope Stability Analysis

PROJECT: Steady State Seepage (piezometers P17, P18, P19)
LOCATION: Buck Steam Station
FILE: BUAP7300
PARTIAL SLOPE CROSS SECTION SHOWN

CIRCLE	X	Y	RADIUS	FS
1	480.0	730.0	62.0	2.00

SOIL*	DENSITY	COHESION	PHI
1	125.0	5000.0	40.0
2	126.0	100.0	25.0
3	125.0	0.0	35.0
4	123.0	0.0	33.0
5	120.0	0.0	32.0
6	123.0	0.0	33.0



* Number after hyphen('-') is Soil Type

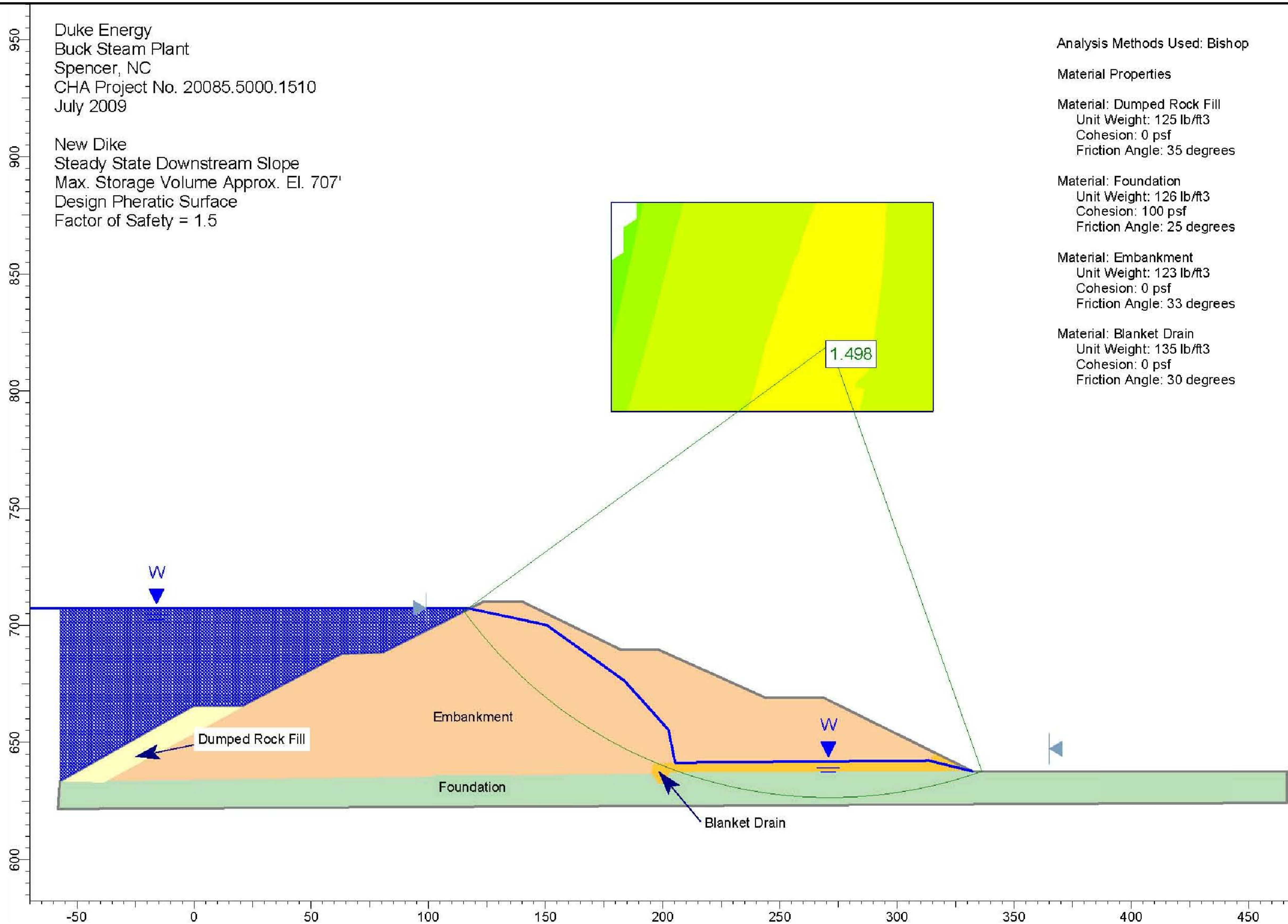
Duke Power Company - Design Engineering Department

Page 106

Drawing Copyright © 2007 CHA

CHA

1996 STABILITY ANALYSIS	PROJECT NO. 20085.5000
BUCK STEAM STATION DUKE ENERGY SPENCER, NORTH CAROLINA	DATE: JULY 2009
	FIGURE 12C



Page 107

Drawing Copyright © 2007 CHA

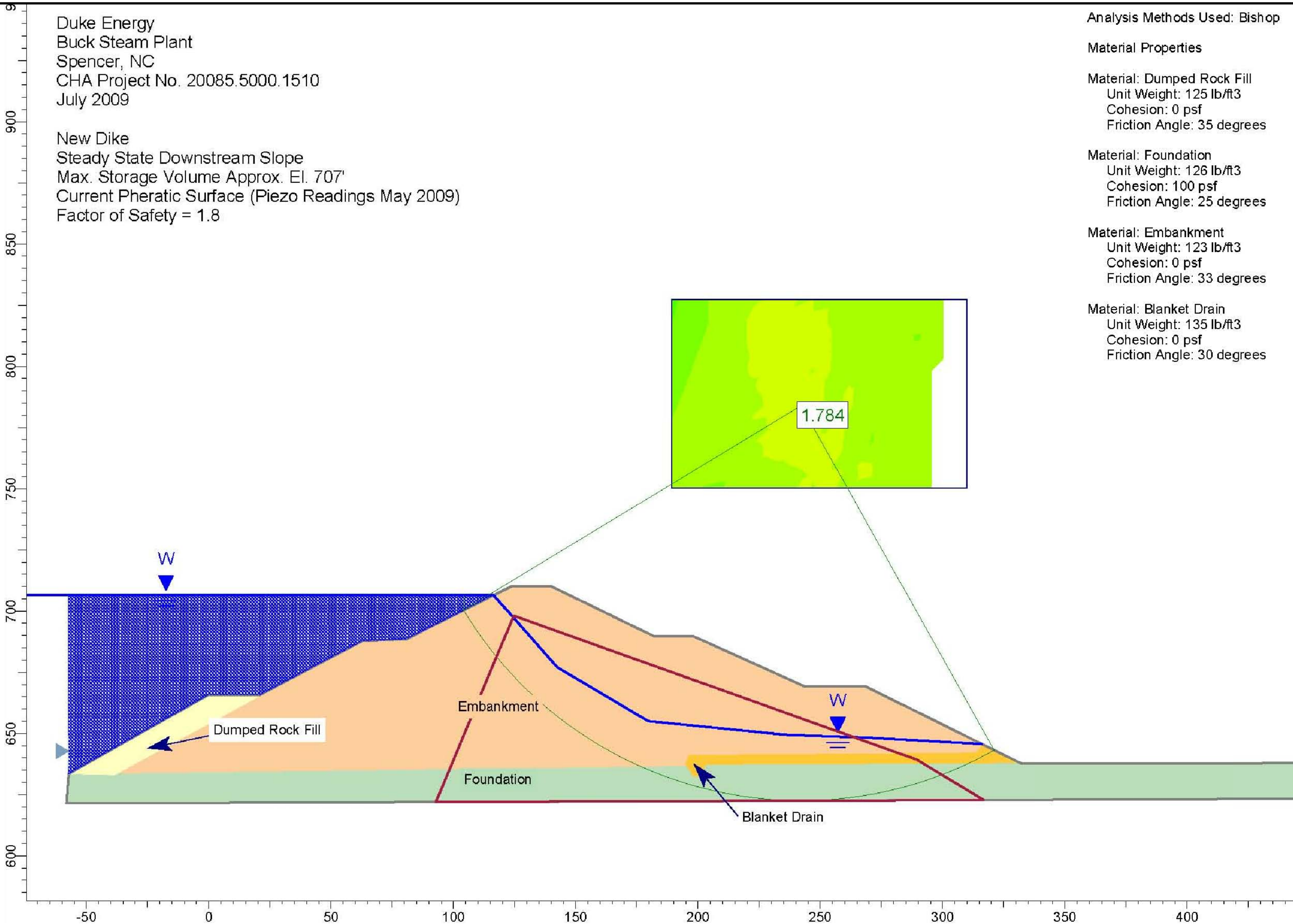
CHA

CROSS SECTION OF NEW DIKE
STABILITY ANALYSIS
BUCK STEAM STATION
DUKE ENERGY
SPENCER, NORTH CAROLINA

PROJECT NO. 20085.5000

DATE: JULY 2009

FIGURE 13



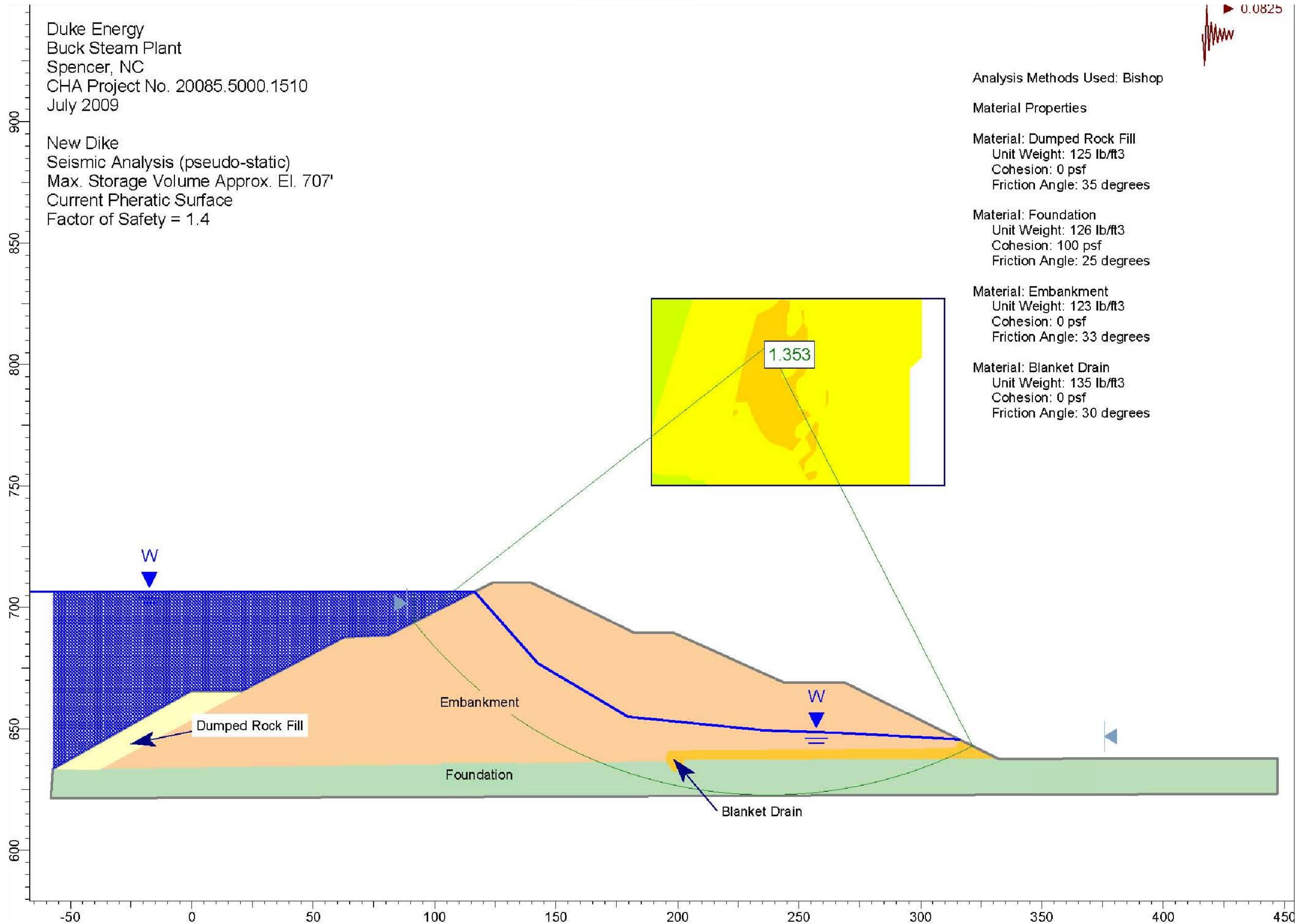
CHA

CROSS SECTION OF NEW DIKE
STABILITY ANALYSIS
BUCK STEAM STATION
DUKE ENERGY
SPENCER, NORTH CAROLINA

PROJECT NO. 20085.5000

DATE: JULY 2009

FIGURE 14



CROSS SECTION OF NEW DIKE
STABILITY ANALYSIS
BUCK STEAM STATION
DUKE ENERGY
SPENCER, NORTH CAROLINA

PROJECT NO. 20085.5000

DATE: JULY 2009

FIGURE 15

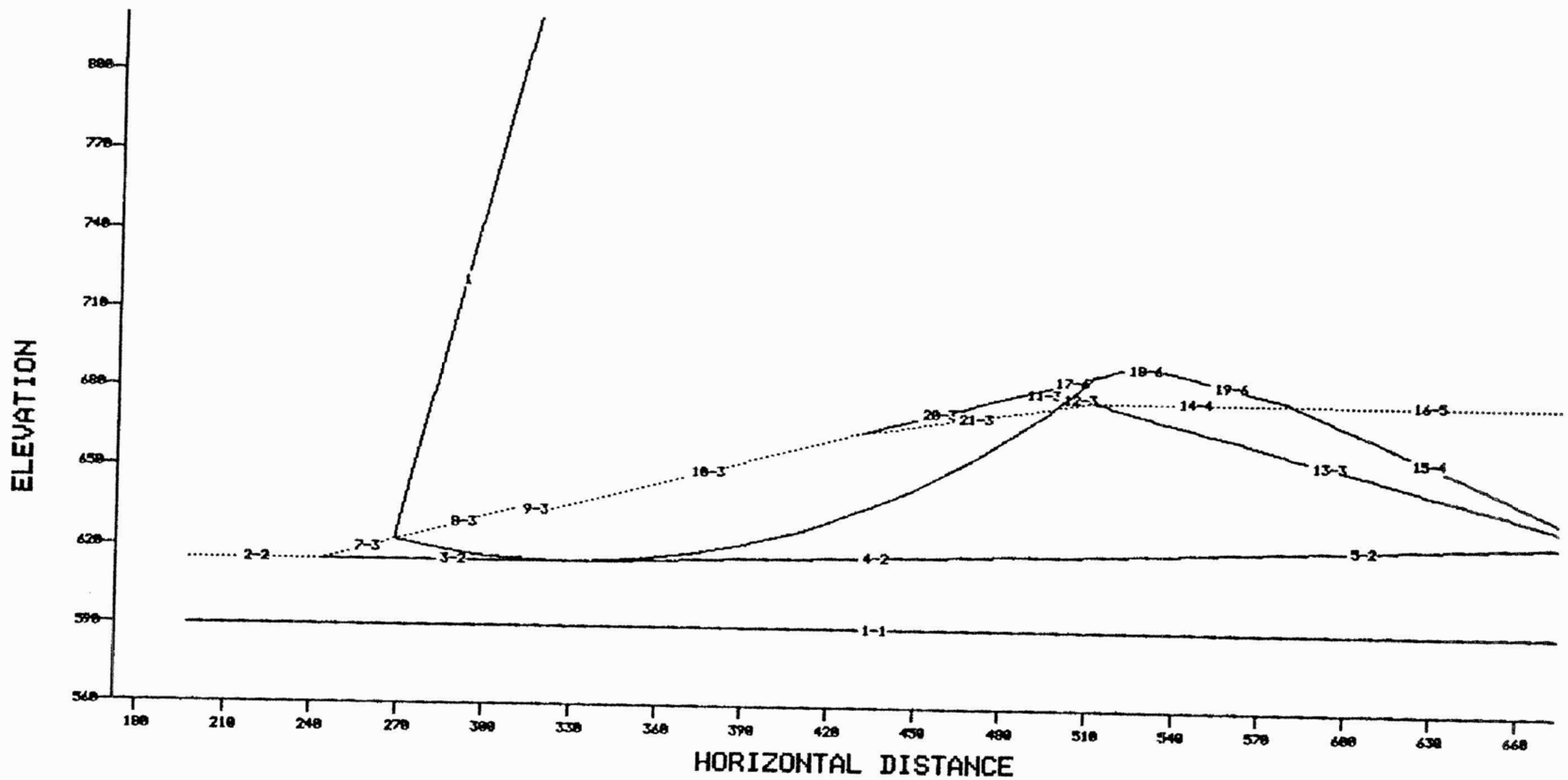
SB-SLOPE

Simplified Bishop Slope Stability Analysis

PROJECT: Steady State Seepage (piezometers P1 - P3, OW1 - OW3)
LOCATION: Buck Steam Station
FILE: BUMD0540
PARTIAL SLOPE CROSS SECTION SHOWN

CIRCLE	X	Y	RADIUS	FS
1	330.0	880.0	264.9	1.43

SOIL*	DENSITY	COHESION	PHI
1	125.0	5000.0	40.0
2	121.0	300.0	34.0
3	113.0	200.0	29.0
4	85.0	0.0	30.0
5	85.0	0.0	16.0
6	120.0	400.0	30.0



* Number after hyphen('-') is Soil Type

Duke Power Company - Design Engineering Department

Drawing Copyright © 2007 CHA

CHA

1996 STABILITY ANALYSIS
BUCK STEAM STATION
DUKE ENERGY
SPENCER, NORTH CAROLINA

PROJECT NO. 20085.5000

DATE: JULY 2009

FIGURE 16A

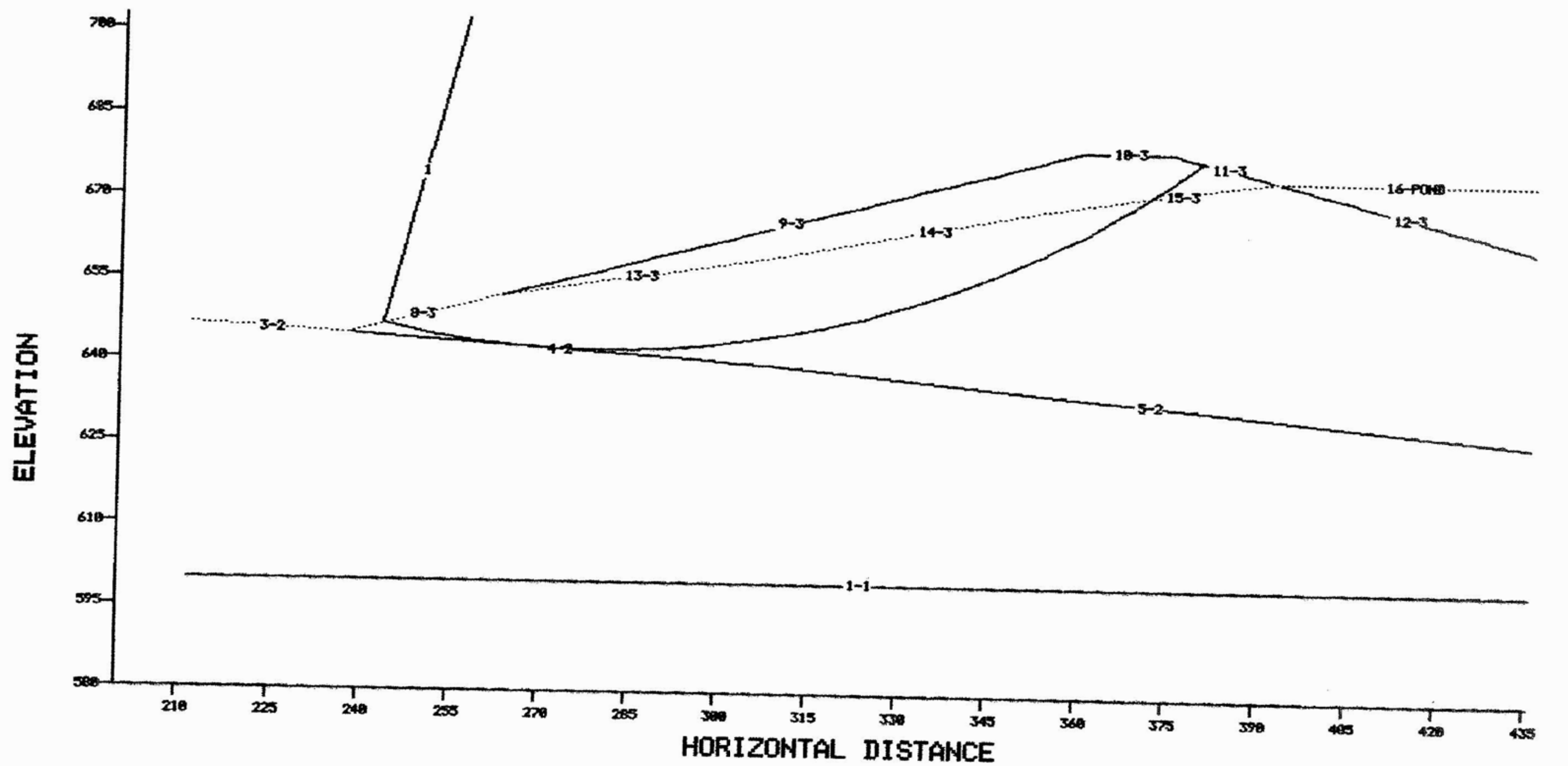
SB-SLOPE

Simplified Bishop Slope Stability Analysis

PROJECT: Steady State Seepage (piezometers P8, OW8, P9, OW9)
LOCATION: Buck Steam Station
FILE: BUMD0750
PARTIAL SLOPE CROSS SECTION SHOWN

CIRCLE	X	Y	RADIUS	FS
1	280.0	800.0	157.4	2.01

SOIL*	DENSITY	COHESION	PHI
1	125.0	5000.0	40.0
2	121.0	300.0	34.0
3	113.0	200.0	29.0



* Number after hyphen('-') is Soil Type

Duke Power Company - Design Engineering Department

Drawing Copyright © 2007 CHA

CHA

1996 STABILITY ANALYSIS
BUCK STEAM STATION
DUKE ENERGY
SPENCER, NORTH CAROLINA

PROJECT NO. 20085.5000

DATE: JULY 2009

FIGURE 16B

Table D1 - Summary of Laboratory Test Data

Buck Landfill Preliminary Engineering Study
Salisbury, North Carolina
S&ME Project No. 1411-08-100

	Boring Number	Sample Depth (feet)	Sample Type	Sample Description	U.S.C.S. Group Symbol	Natural Moisture %	Insitu Dry Unit Weight (pcf)	Specific Gravity	Grain Size Analysis				Atterberg Limits		Standard Proctor Compaction		CU Triaxial Shear Strength		Consolidation
									gravel %	sand %	silt %	clay %	LL %	PI %	MDD pcf	OMC %	Friction angle Φ'	cohesion c' (psf)	Cv (avg) (ft2/day)
Main Dike	B-2	25-27	SH	Orange Tan Brown Clayey Silty Fine to Medium Sand with Mica (Fill)	SM	24.1 / 20.8	101.3 / 100.4	2.70	0.0	58.3	30.2	11.5	44	14	-	-	27.8	370	-
Main Dike	B-3	15.5-17.5	SH	Tan Red Brown Fine to Medium Sandy Clayey Silt with Mica (Fill)	ML	20.0 / 22.3 / 24.9	104.0 / 101.4 / 96.0	2.68	0.0	46.0	35.5	18.5	44	14	-	-	27.1	300	-
Main Dike	B-3	35.5-37.5	SH	Tan Red Brown Fine to Medium Sandy Silty Clay with Mica (Fill)	CL	24.1 / 30.9	101.0 / 87.6	2.67	0.3	42.5	22.8	34.5	43	22	-	-	26.9	300	-
Main Dike	B-15	15-17	SH	Tan Red Brown Fine to Medium Sandy Silty Clay (Fill)	CH	30.0 / 28.5 / 25.3	97.8 / 95.9 / 97.0	2.71	1.7	35.3	23	40.0	55	30	-	-	28.8	310	-
Main Dike	B-15	35-36.7	SH	Red Tan Brown Fine to Medium Clayey Silt with Mica (Fill)	MH	32.5 / 27.1	86.4 / 92.9	2.65	0.9	36.6	35.9	26.5	55	21	-	-	29.9	330	-
Intermediate Dike	B-8	30.5-32.5	SH	Black Gray Silty Coarse to Fine Sand (Ash)	SM	44.0 / 23.7	75.8 / 66.5	2.23	2.4	74.2	20.5	3.0	NP	NP	-	-	39.2	90	-
Intermediate Dike	B-9	10.5-12.5	SH	Red Brown Medium to Fine Sandy Clay (Fill)	CH	23.3	99.3	2.67	0.0	33.0	22.5	44.5	65	35	-	-	40*	0*	-
Intermediate Dike	B-12	20.6-22.6	SH	Black Gray Silty Medium to Fine Sand (Ash)	SM	11.1 / 11.1	74.8 / 66.1	2.13	0.0	66.8	30.2	3.0	NP	NP	-	-	37.6	10	-
Intermediate Dike	B-13	10.5-12.5	SH	Orange Brown Medium to Fine Sandy Clayey Silt (Fill)	MH	23.2 / 29.0 / 23.8	99.3 / 84.7 / 99.9	2.67	0.1	43.2	24.2	32.5	53	23	-	-	32.5	190	-
Intermediate Dike	B-13	25.5-27.5	SH	Black Gray Silt with Fine Sand (Ash)	ML	55.2 / 41.7 / 49.0	56.4 / 63.9 / 55.2	2.17	0.0	20.0	77.0	3.0	NP	NP	-	-	33.7	20	-
Ash Basin	B-4	10.6-12.6	SH	Black Gray Coarse to Fine Sandy Silt (Ash)	ML	38.5	71.3	2.23	1.2	49.0	43.8	6.0	NP	NP	-	-	35.7	0*	-
Ash Basin	B-4	25.6-27.6	SH	Black Gray Silty Coarse to Fine Sand (Ash)	SM	47.1 / 47.1 / 36.6	50.5 / 62.2 / 54.7	2.26	1.2	68.3	28.5	2.0	NP	NP	-	-	33.1	280	-
Ash Basin	B-10	15.5-17.5	SH	Black Gray Silty Coarse to Fine Sand (Ash)	SM	45	65.9	2.17	3.1	50.6	40.3	6.0	NP	NP	-	-	-	-	4.67
Ash Basin	B-10	20.5-22.5	SH	Black Gray Silty Coarse to Fine Sand (Ash)	SM	45.9 / 37.4	63.1 / 71.6	2.24	1.3	79.1	17.5	2.0	NP	NP	-	-	36.2	410	-
Ash Basin	B-10	35.5-37.5	SH	Black Gray Silty Medium to Fine Sand (Ash)	SM	54.6	60.9	2.23	0.0	71.4	25.6	3.0	NP	NP	-	-	-	-	11.54
Ash Basin	B-11	10.6-12.6	SH	Black Gray Silty Coarse to Fine Sand (Ash)	SM	53	58.3	2.38	6.9	71.0	20.6	1.5	NP	NP	-	-	-	-	12.29
Ash Basin	B-11	15.6-17.6	SH	Black Gray Silty Coarse to Fine Sand (Ash)	SM	72.5 / 72.5	50.2 / 54.3	2.14	4.8	56.6	36.2	2.5	NP	NP	-	-	36.4	30	-
Ash Basin	B-17	5.7-7.7	SH	Black Gray Silt w/Coarse to Fine Sand (Ash)	ML	48.2	57.6	2.30	0.8	25.8	66.4	7.0	NP	NP	-	-	-	-	15.77
Landfill Ash	Bag A	0-3	bulk	Gray Black Silt with Fine Sand (Ash)	ML	70.1 / 74.3 *	54.0 / 52.2 *	2.230	2.0	23.9	72.1	2.0	NP	NP	68.7	35.1	33.5	150	-
Landfill Ash	Bag B	0-3	bulk	Gray Black Silt with Fine Sand (Ash)	ML	75.1 / 77.5 *	51.7 / 50.6 *	2.170	0.1	21.0	77.0	2.0	NP	NP	63.8	40.9	34.6	50	-
Landfill Ash	Bag C	0-3	bulk	Gray Black Silt (Ash)	ML	74.9 / 74.6 *	51.9 / 51.4 *	2.150	0.0	4.2	92.8	3.0	NP	NP	65.6	40.2	33.8	70	-

*values from measurement of moisture content and bulk unit weight of bucket sample obtained from surface of active ash basin

*only 1 point obtained. Assumed c'=0

Abbreviations

SS-Split Spoon SH - Shelby Tube

USCS – Unified Soil Classification System

LL - Liquid Limit, PI - Plasticity Index, "NP" indicates non-plastic

MDD - Maximum Dry Density, OMC - Optimum Moisture Content

"-" indicates test not performed

Notes

1) % clay based on hydrometer test and includes all particles smaller than .005 mm

2) Refer to individual laboratory test data sheets for details on test methods and results

CHA

SUMMARY OF LAB TEST RESULTS
BUCK STEAM STATION
DUKE ENERGY
SPENCER, NORTH CAROLINA

PROJECT NO. 20085.5000

DATE: JULY 2009

FIGURE 17

TABLE F4 - Summary of Materials and Parameters for Static Stability Analysis

Profile MD-A

Material	USCS Classification of Predominant Soils Types	Moist Unit Weight γ_m (pcf)	Saturated Unit Weight γ_{sat} (pcf)	Drained Shear Strength: Friction Angle Φ' (degrees)	Drained Shear Strength: Cohesion c' (psf)	Undrained Shear Strength S_u (psf)
Ash Landfill	ML, SM (ash)	90	NA	30	0	not applicable
Retired Ash Basin	ML, SM (ash)	85	90	24	0	function of depth (Su=100 psf at ash basin surface, +15 psf per foot depth)
Main Dike Fill - Original	ML, CL, CH, MH, SM	120	122	27	200	function of depth (Su=800 psf at top, +13 psf per foot depth)
Main Dike Fill - Stage IA and IB	ML, CL, CH, MH, SM	120	122	27	200	function of depth (Su=800 psf at top, +13 psf per foot depth)
Alluvium / Residuum	ML, CL, CH, MH, SM	115	120	28	200	Su = 900 psf
Partially Weathered Rock (PWR)	SM, ML	120	125	36	500	not applicable

CHA

MATERIALS AND PARAMETERS USED FOR STABILITY ANALYSIS
BUCK STEAM STATION
DUKE ENERGY
SPENCER, NORTH CAROLINA

PROJECT NO. 20085.5000

DATE: JULY 2009

FIGURE 18

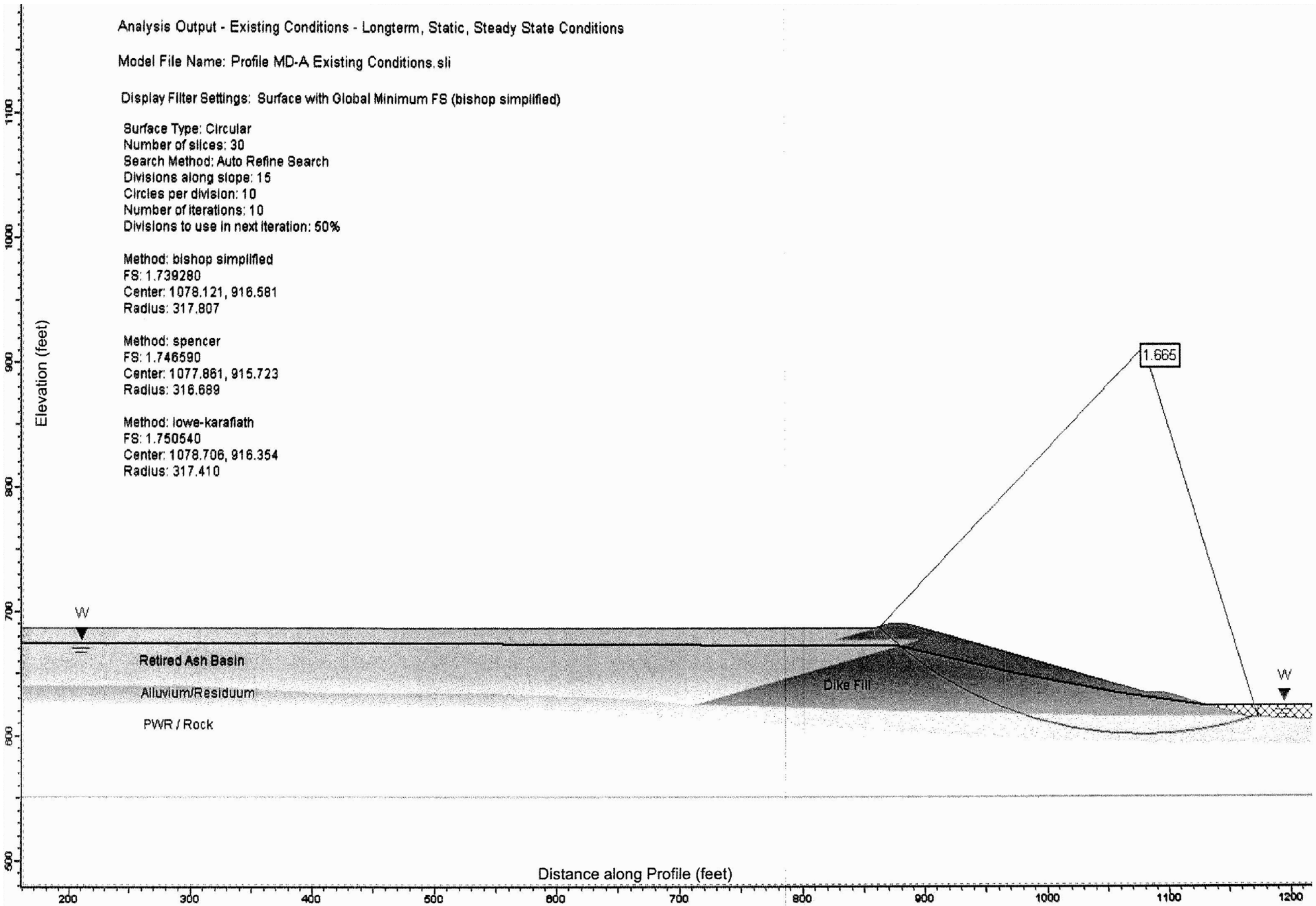


IMAGE REFERENCE: SM&E, BUCK LANDFILL PRELIMINARY ENGINEERING STUDY, PROFILE MD–A, FIGURE F2, 1–23–09

CHA

CROSS SECTION ANALYZED
BUCK STEAM STATION
DUKE ENERGY
SPENCER, NORTH CAROLINA

PROJECT NO. 20085.5000

DATE: JULY 2009

FIGURE 19

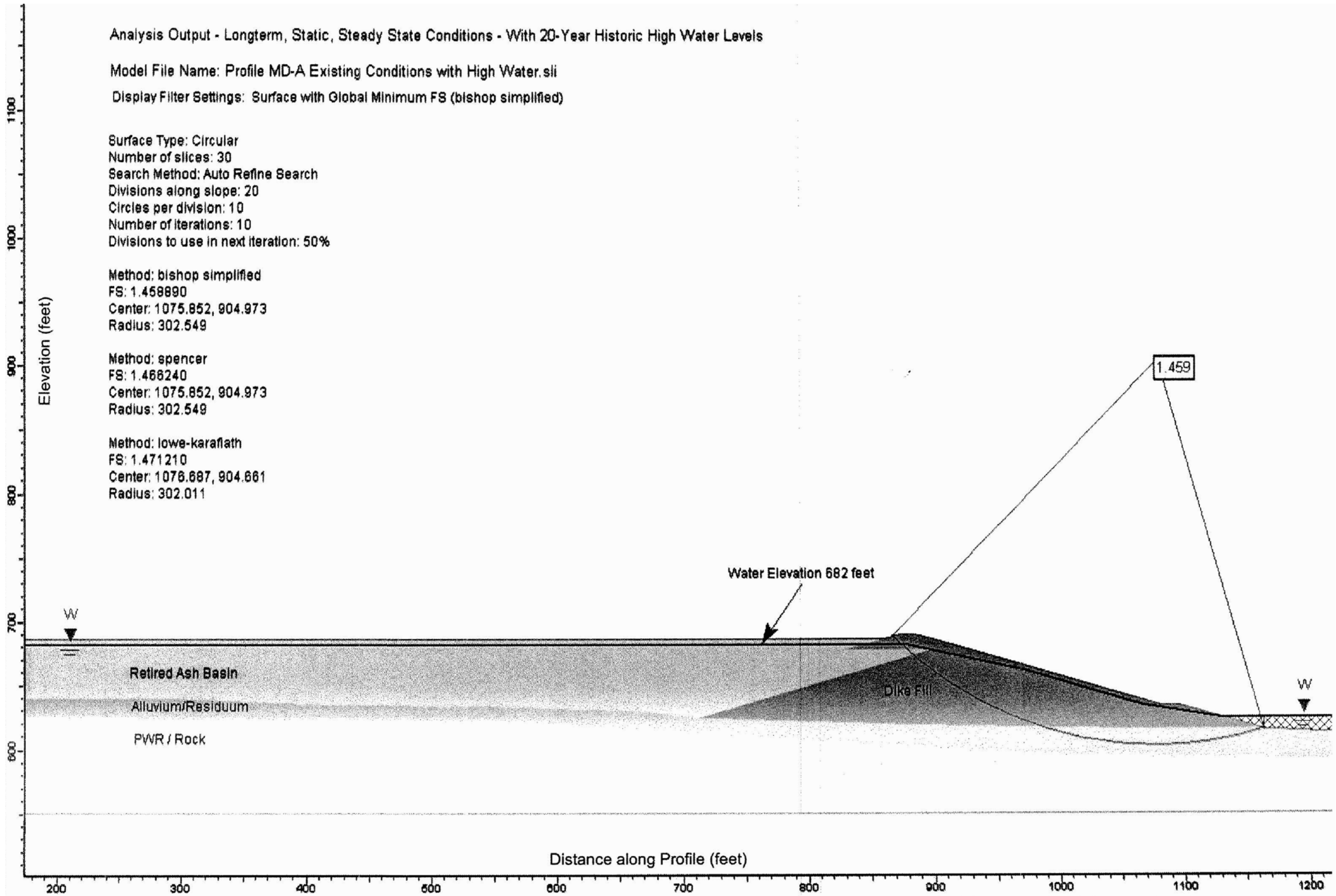


IMAGE REFERENCE: SM&E, BUCK LANDFILL PRELIMINARY ENGINEERING STUDY, PROFILE MD-A, FIGURE F4, 1-23-09

Drawing Copyright © 2007 CHA

CHA

CROSS SECTION ANALYZED

BUCK STEAM STATION
DUKE ENERGY
SPENCER, NORTH CAROLINA

PROJECT NO. 20085.5000

DATE: JULY 2009

FIGURE 20

Duke Energy
Buck Steam Plant
Spencer, NC
CHA Project No. 20085.5000.1510
July 2009

Main Dike Adjacent to Basin 2
Steady State Downstream Slope
Storage Volume Approx. El. 676'
Factor of Safety = 1.6

Analysis Methods Used: Bishop

Material Properties

Material: Main Dike Fill - Original
Unit Weight: 120 lb/ft3
Cohesion: 200 psf
Friction Angle: 27 degrees

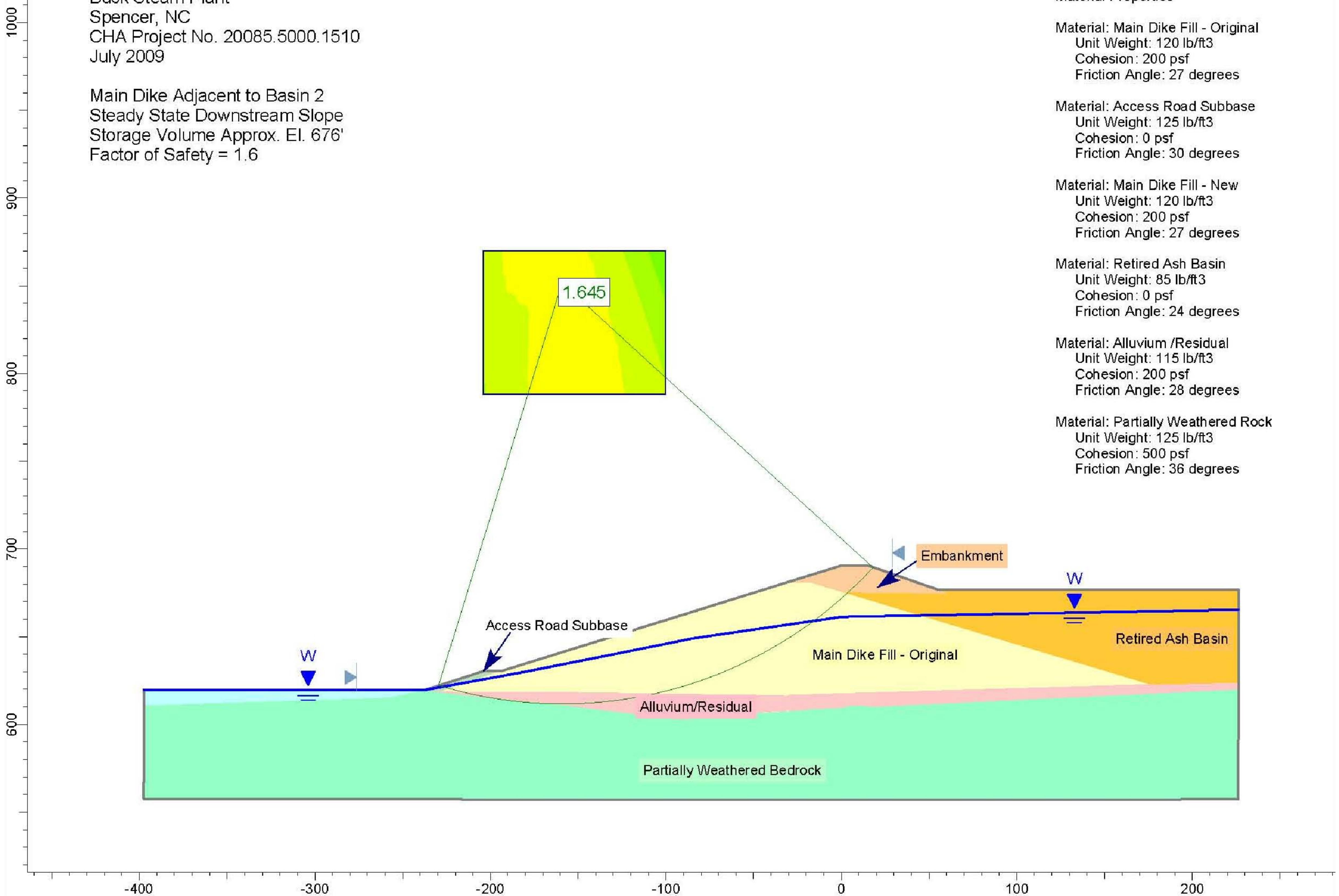
Material: Access Road Subbase
Unit Weight: 125 lb/ft3
Cohesion: 0 psf
Friction Angle: 30 degrees

Material: Main Dike Fill - New
Unit Weight: 120 lb/ft3
Cohesion: 200 psf
Friction Angle: 27 degrees

Material: Retired Ash Basin
Unit Weight: 85 lb/ft3
Cohesion: 0 psf
Friction Angle: 24 degrees

Material: Alluvium /Residual
Unit Weight: 115 lb/ft3
Cohesion: 200 psf
Friction Angle: 28 degrees

Material: Partially Weathered Rock
Unit Weight: 125 lb/ft3
Cohesion: 500 psf
Friction Angle: 36 degrees

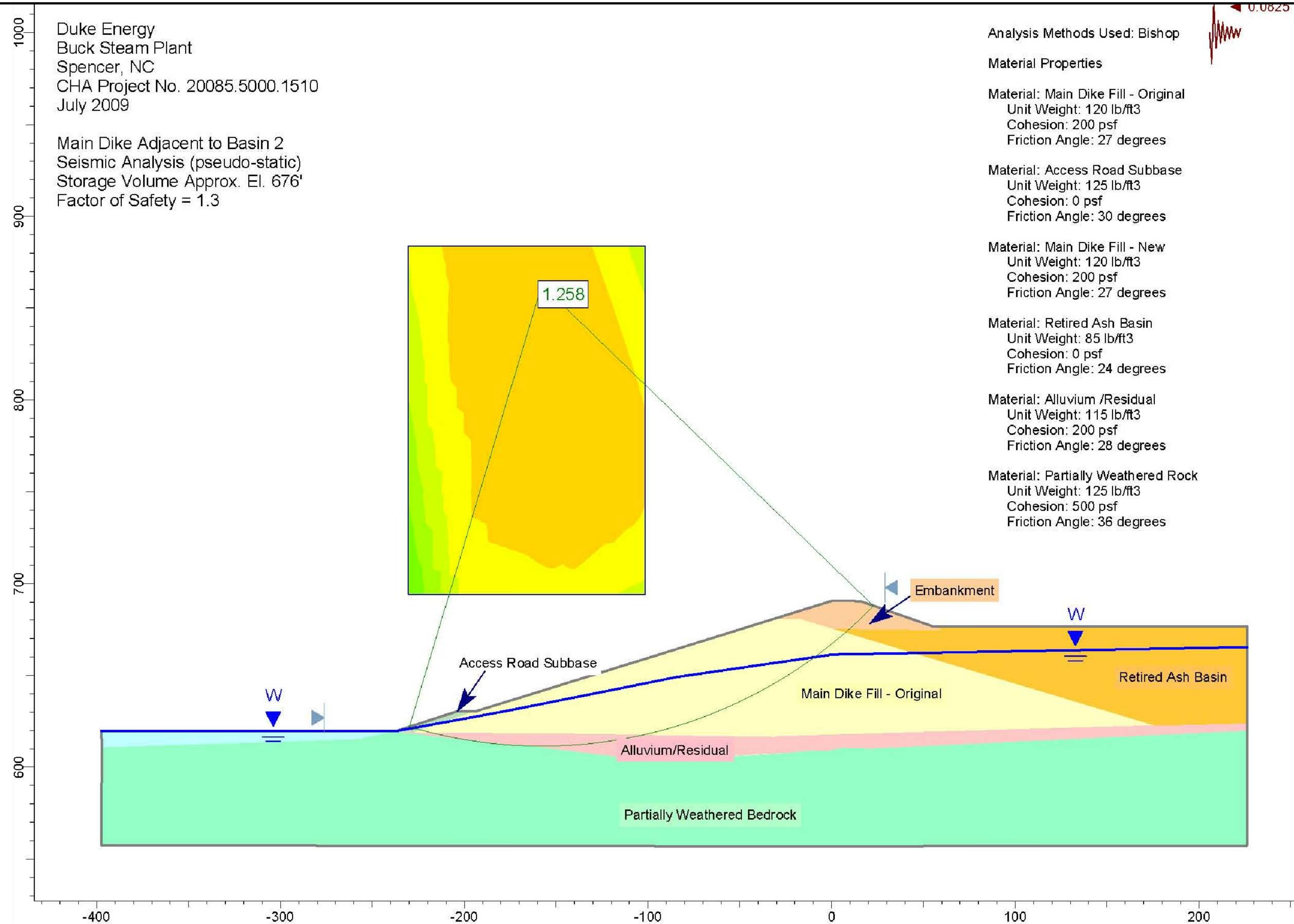


CROSS SECTION OF MAIN DIKE STABILITY ANALYSIS
BUCK STEAM STATION
DUKE ENERGY
SPENCER, NORTH CAROLINA

PROJECT NO. 20085.5000

DATE: JULY 2009

FIGURE 21



Drawing Copyright © 2007 CHA

CHA

CROSS SECTION OF MAIN DIKE STABILITY ANALYSIS
BUCK STEAM STATION
DUKE ENERGY
SPENCER, NORTH CAROLINA

PROJECT NO. 20085.5000

DATE: JULY 2009

FIGURE 22

Duke Energy
Buck Steam Plant
Spencer, NC
CHA Project No. 20085.5000.1510
July 2009

Main Dike Adjacent to Basin 3
Steady State Downstream Slope
Storage Volume Approx. El. 676'
Factor of Safety = 1.9

Analysis Methods Used: Bishop

Material Properties

Material: Main Dike Fill - Original
Unit Weight: 120 lb/ft3
Cohesion: 200 psf
Friction Angle: 27 degrees

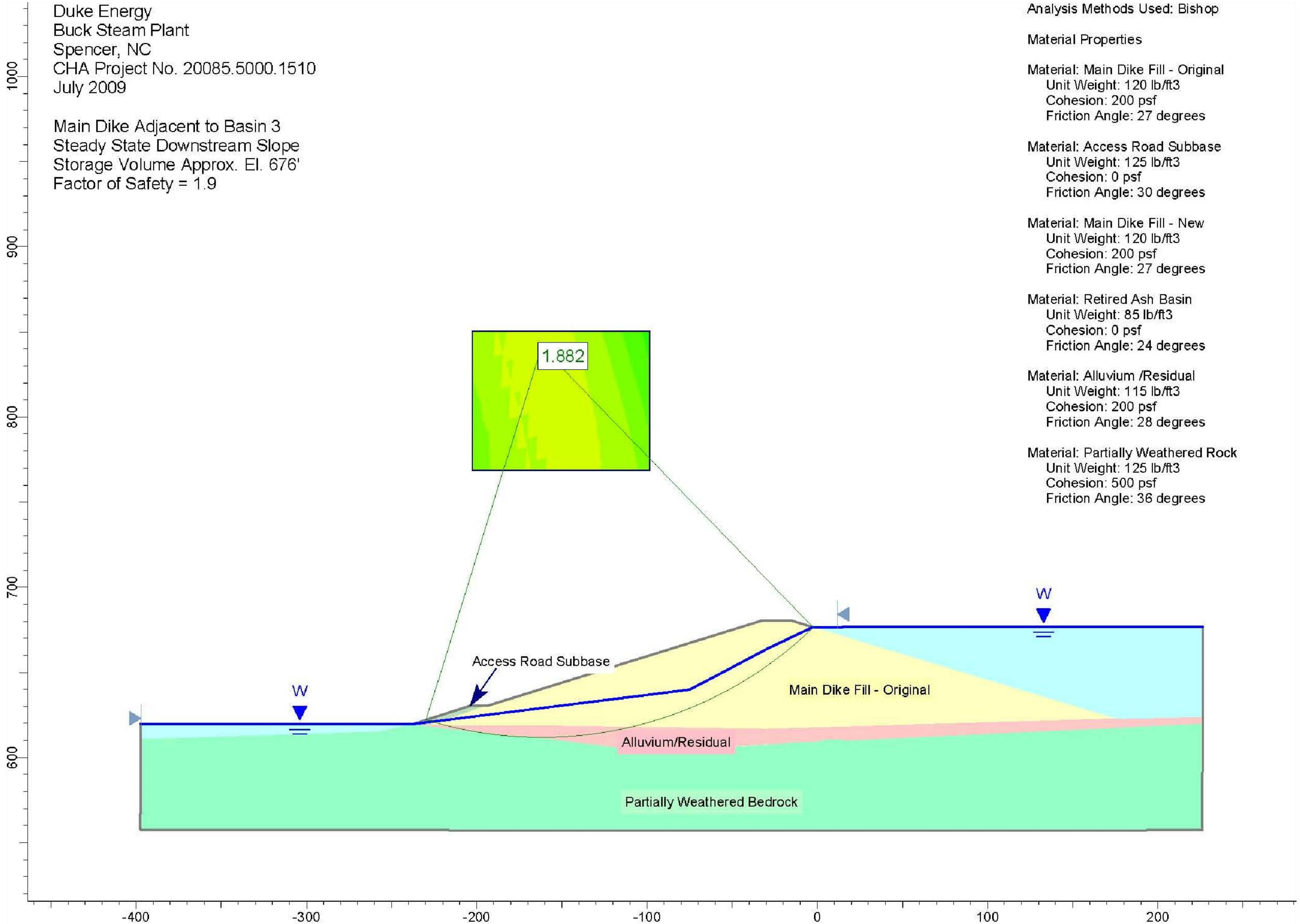
Material: Access Road Subbase
Unit Weight: 125 lb/ft3
Cohesion: 0 psf
Friction Angle: 30 degrees

Material: Main Dike Fill - New
Unit Weight: 120 lb/ft3
Cohesion: 200 psf
Friction Angle: 27 degrees

Material: Retired Ash Basin
Unit Weight: 85 lb/ft3
Cohesion: 0 psf
Friction Angle: 24 degrees

Material: Alluvium /Residual
Unit Weight: 115 lb/ft3
Cohesion: 200 psf
Friction Angle: 28 degrees

Material: Partially Weathered Rock
Unit Weight: 125 lb/ft3
Cohesion: 500 psf
Friction Angle: 36 degrees



CHA

CROSS SECTION OF MAIN DIKE STABILITY ANALYSIS
BUCK STEAM STATION
DUKE ENERGY
SPENCER, NORTH CAROLINA

PROJECT NO. 20085.5000
DATE: JULY 2009
FIGURE 23

Duke Energy
Buck Steam Plant
Spencer, NC
CHA Project No. 20085.5000.1510
July 2009

Main Dike Adjacent to Basin 3
Flood Condition
Storage Volume Approx. El. 680'
Factor of Safety = 1.8

Analysis Methods Used: Bishop

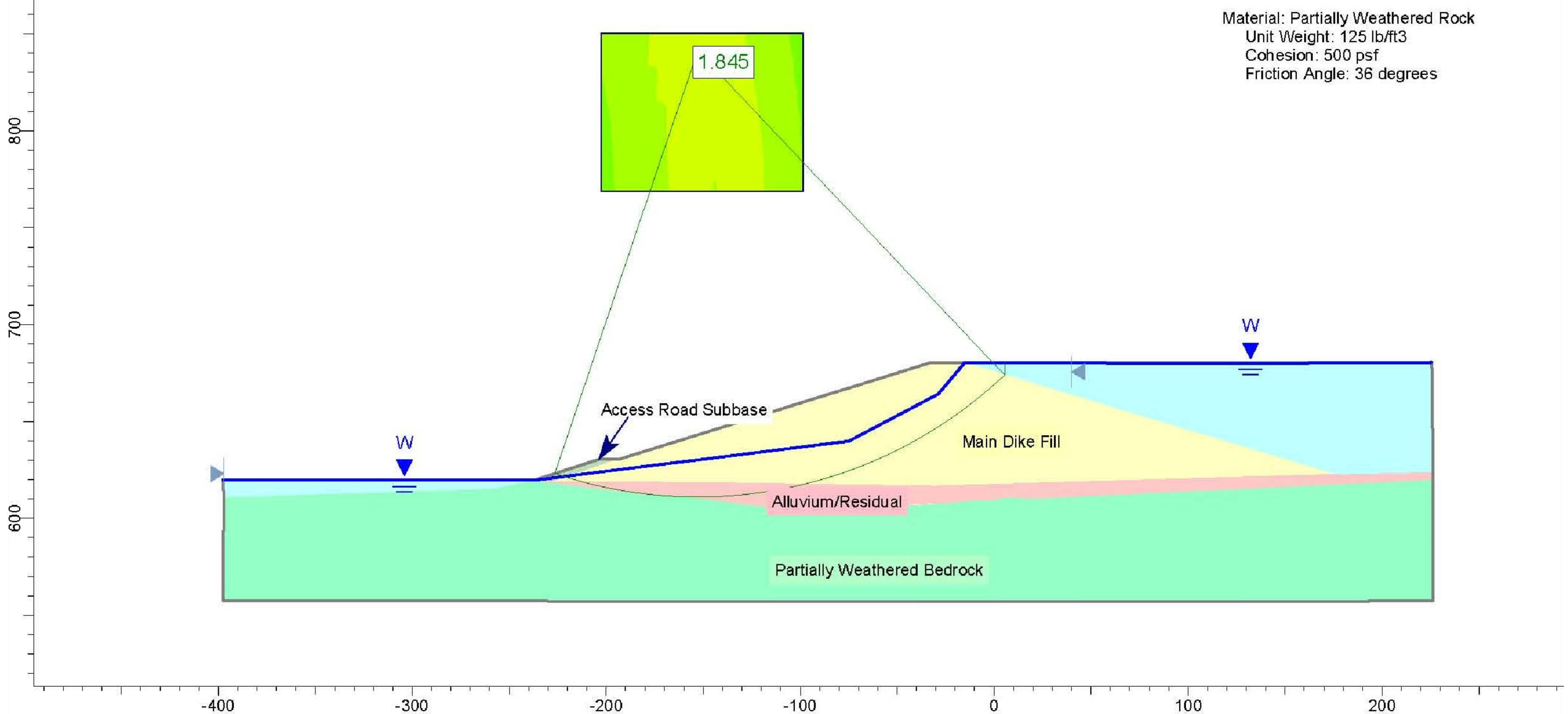
Material Properties

Material: Main Dike Fill
- Unit Weight: 120 lb/ft3
- Cohesion: 200 psf
- Friction Angle: 27 degrees

Material: Access Road Subbase
- Unit Weight: 125 lb/ft3
- Cohesion: 0 psf
- Friction Angle: 30 degrees

Material: Alluvium /Residual
- Unit Weight: 115 lb/ft3
- Cohesion: 200 psf
- Friction Angle: 28 degrees

Material: Partially Weathered Rock
- Unit Weight: 125 lb/ft3
- Cohesion: 500 psf
- Friction Angle: 36 degrees



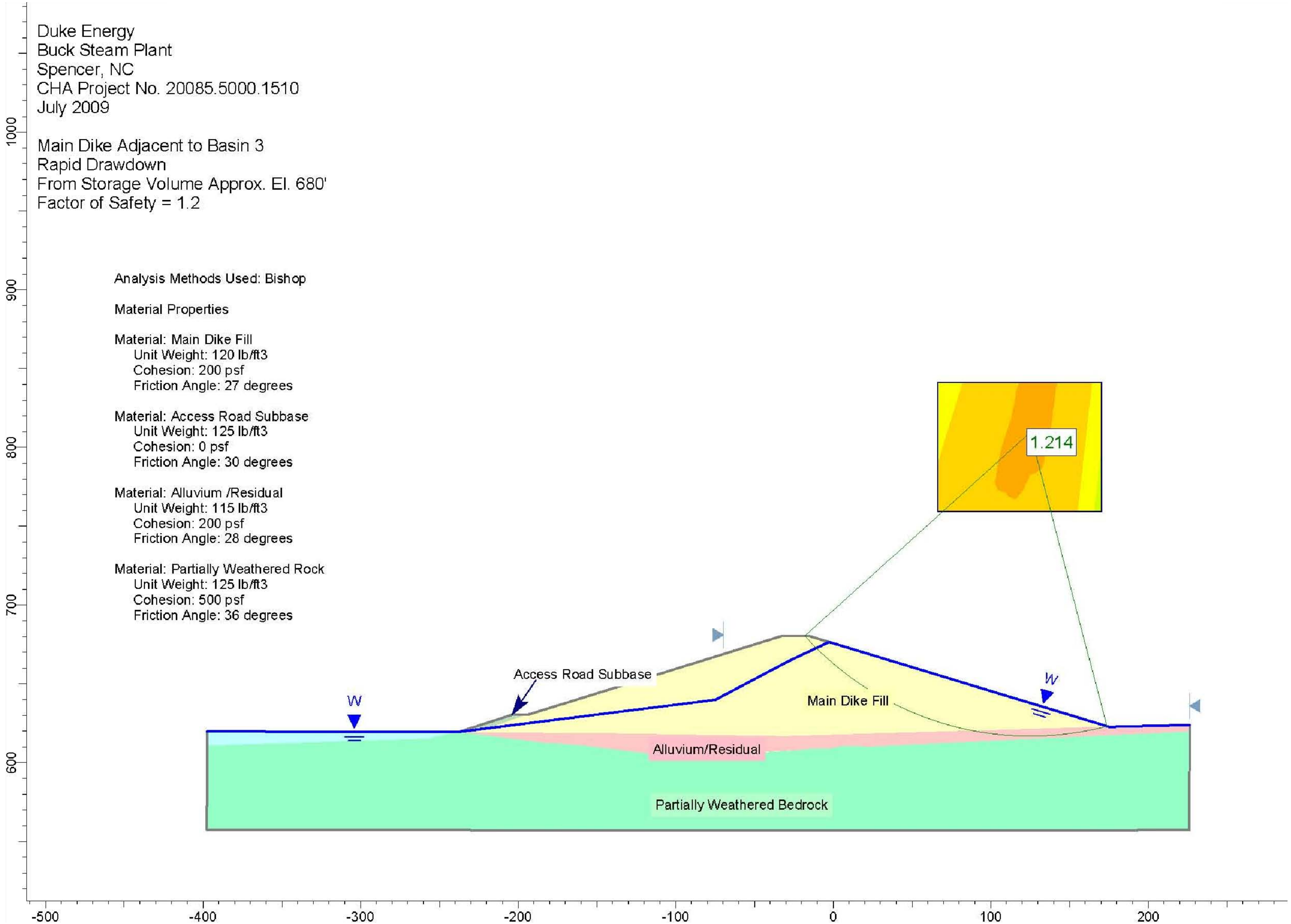
CHA

CROSS SECTION OF MAIN DIKE STABILITY ANALYSIS
BUCK STEAM STATION
DUKE ENERGY
SPENCER, NORTH CAROLINA

PROJECT NO. 20085.5000

DATE: JULY 2009

FIGURE 24



Drawing Copyright © 2007 CHA

CHA

CROSS SECTION OF MAIN DIKE STABILITY ANALYSIS
BUCK STEAM STATION
DUKE ENERGY
SPENCER, NORTH CAROLINA

PROJECT NO. 20085.5000

DATE: JULY 2009

FIGURE 25

Duke Energy
Buck Steam Plant
Spencer, NC
CHA Project No. 20085.5000.1510
July 2009

Main Dike Adjacent to Basin 3
Seismic Analysis (pseudo-static)
Storage Volume Approx. El. 676'
Factor of Safety = 1.4

Analysis Methods Used: Bishop

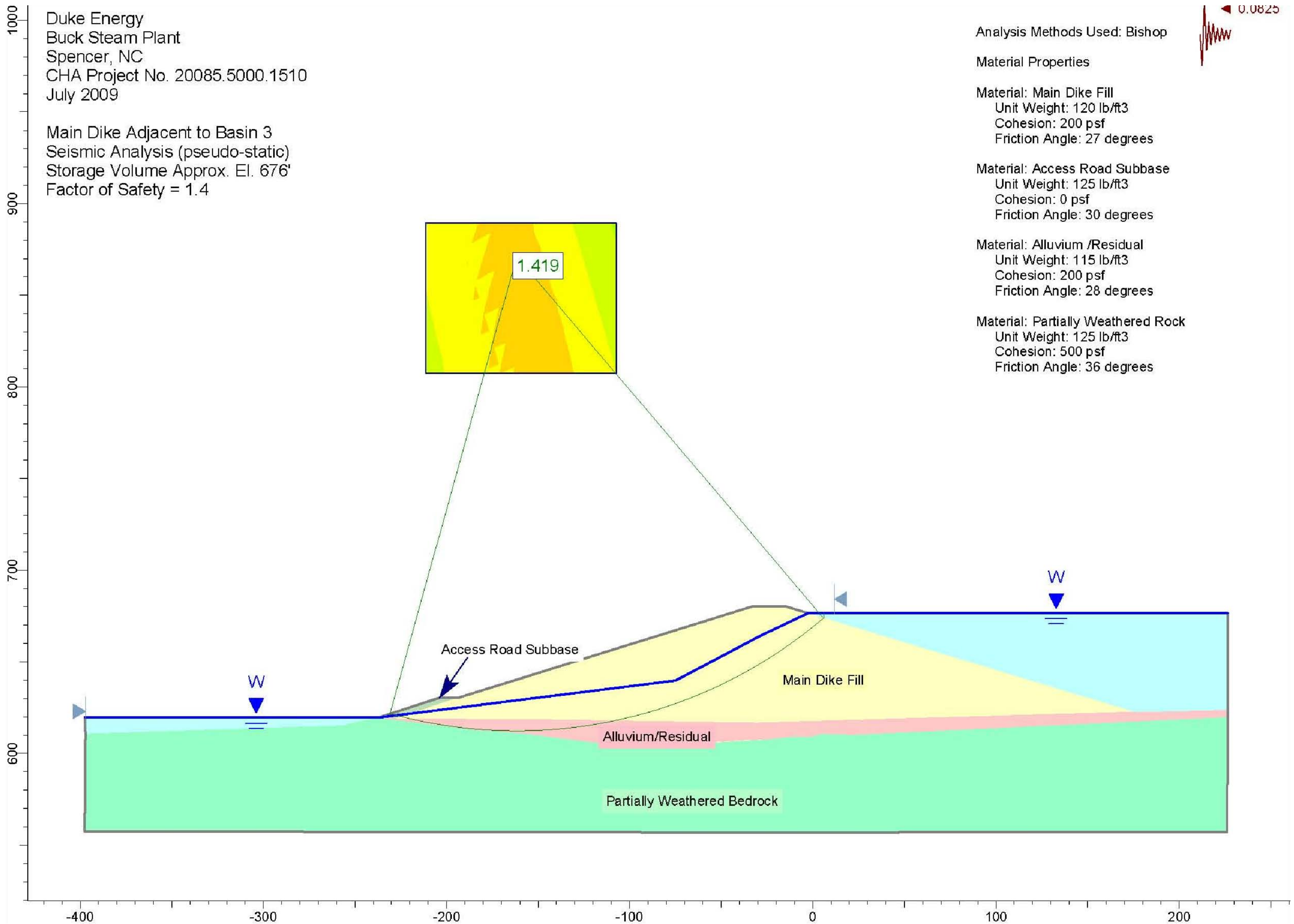
Material Properties

Material: Main Dike Fill
Unit Weight: 120 lb/ft3
Cohesion: 200 psf
Friction Angle: 27 degrees

Material: Access Road Subbase
Unit Weight: 125 lb/ft3
Cohesion: 0 psf
Friction Angle: 30 degrees

Material: Alluvium /Residual
Unit Weight: 115 lb/ft3
Cohesion: 200 psf
Friction Angle: 28 degrees

Material: Partially Weathered Rock
Unit Weight: 125 lb/ft3
Cohesion: 500 psf
Friction Angle: 36 degrees



CHA

CROSS SECTION OF MAIN DIKE STABILITY ANALYSIS
BUCK STEAM STATION
DUKE ENERGY
SPENCER, NORTH CAROLINA

PROJECT NO. 20085.5000

DATE: JULY 2009

FIGURE 26

4.0 CONCLUSIONS/RECOMMENDATIONS

4.1 Acknowledgement of Management Unit Condition

I acknowledge that the management units referenced herein was personally inspected by me and were found to be in the following condition: **Satisfactory**.

CHA's assessment of the new dike, main dike and diverter dike indicate that they are in satisfactory condition. Duke Energy provided CHA with descriptions of a proactive maintenance and monitoring program at these facilities. These efforts should be continued.

CHA presents recommendations for maintenance and further studies to bring these facilities into Satisfactory in the following sections.

4.2 Vegetation Control

While CHA observed appropriate grass cover that had been recently mowed, taller weeds were growing adjacent to the upstream ash and dike contact. We recommend these weeds be cut during the routine mowing and vegetation control maintenance to prevent undesirable wood brush and trees from establishing where their roots could penetrate the embankment.

Sparse vegetation was noted in localized areas on each of the dikes. In these areas of sparse vegetation, reseeding maintenance should be performed.

4.3 Drainage Swales

Sediment was evident in rip rap drainage swales. The sediment observed appeared to be related to surface runoff and tended to be accumulated at the toe of the swales. Duke Energy should monitor the condition of these drainage swales and if the sediment appears to be clogging the rip rap and impeding surface runoff from being adequately conveyed away from the earthen embankments, the rip rap should be cleaned of sediment.

4.4 Main Dike Crest

A low area was observed on the downstream side of the main dike across from the outlet tower access path as noted in Section 2.3.1. We recommend this low spot be re-graded to prevent surface runoff from the crest concentrating in this area, and marked in the field, so Duke Energy personnel can observe for further changes during routine inspections. Should any unusually large amount of sediment appear in the rip rap swales at any one time, particularly after rain events, plant personnel should inspect the dike slope and crest areas because this could be a sign of decreased grass cover and increase erosion activity.

4.5 Animal Control

CHA observed several areas where disturbed soil was observed on the dam embankments because of animal activity. Disturbed areas that result in loose soil and vegetation removal should be monitored during routine inspections and re-graded and seeded as needed to keep these areas stable. Paths, such as the beaver or muskrat slide seen on the Basin 2 to 3 dam, should be observed for deepening and runoff erosion as these areas will concentrate storm water runoff.

CHA did not observe signs of burrowing animals, but Duke Energy personnel indicated they have had to trap woodchucks at their fuel tank containment berm, so Duke Energy should remain vigilant during inspections looking for signs of burrowing animals on the dikes as well.

4.6 Seepage

CHA understands from conversations with Duke Energy personnel that they are currently discussing seepage control and measuring options with their consultant to help quantify the seepage conditions at the toe of the new dike. CHA recommends that a plan be developed and implemented that includes monitoring a weir. A monitoring weir allows for this quantitative measurement of seepage flow so that changes can be more easily identified, and it allows a sampling point to collect seepage flow for observation of soil particles being carried by the flow.

Seepage was also observed around the headwall of the outlet pipe at the Basin 1 to Basin 2 dam. CHA recommends this seepage be monitored during Duke Energy's monthly inspections of their ash pond facilities. Because of the discharge channel water level, this is not a location conducive to installation of a monitoring system.

4.7 Wooded Area of Main Dike

CHA recommends that Duke Energy have an independent consultant evaluate the neglected portion of the main dike. This area of the dike does not impound water under the current normal operating pool. However, this area will impound water under flood conditions. Therefore, this portion of the dike should be evaluated for determination of its ability to hold back flood water volumes.

4.8 Ash and Vegetation at Basin 2 to Basin 3 Outlet Control Structure

Ash is piled around the Basin 2 to Basin 3 outlet control structure and significant vegetation has been established in this ash. The vegetation and ash should be removed so as not to impede flow into the outlet structure.

4.9 Depressions on Diverter Dike

CHA recommends that depressions and erosion swales on the diverter dike be re-graded and re-seeded and then monitored for changes.

4.10 Monitoring Instrumentation

There are conclusions and recommendations in the 2008 inspection report suggesting that some of the piezometers at the new and main dike are damaged and should be replaced with new piezometers with screens at the same elevations. CHA strongly recommends that these piezometers are reinstalled particularly at the new dike where there have been concerns about elevated phreatic surface in the past. Well operating monitoring points can show signs of change in the dike that need to be addressed before signs become visible at the ground surface.

4.11 Hydrologic and Hydraulic Evaluation Update

Preliminary analyses suggest that the ash basins at Buck Steam Station will safely pass the ¾ PMF. However, these analyses suggest the water levels in Basin 2 will rise to within 0.6 feet of the dam crest. Because of the preliminary nature of these analyses, CHA recommends Duke Energy evaluate the basin system for safe passage of the ¾ PMF and make adjustment to operating procedures as needed to meet freeboard requirements satisfactory to the North Carolina Utilities Commission.

4.12 Hazard Assessment

We recommend that a breach analysis be performed to determine whether development downstream from the main dike (e.g. residential development approximately 3 miles downstream) would suggest a high hazard classification is warranted for the impoundment.

We also recommend that a breach analysis be performed for the new dike to determine if the Buck Steam Station access road and parking areas would be impacted by a failure of the dike and if a high hazard classification is warranted.

4.13 Additional Stability Analyses – New Dike

We recommend that an investigation be performed in which the properties of the embankment and foundation soils be investigated. Based on the documentation we have reviewed it appears that it has been some time, over 15 years, since a detailed investigation has been performed for the new dike. Independent consultant reports have summarized changes over time in the new dike, including some piezometers readings above the design pheratic surface (Piezometers P15 and 16). Current piezometer data (May 2009) indicates that other piezometers readings are below the design pheratic surface (Piezometers P13 and P14). The 2008 Annual Inspection Report notes that piezometers P15 and P16 are damaged. The recommended investigation should include the installation of additional piezometers to determine the current pheratic surface and to replace any damaged piezometers. The investigation should include a detailed stability analysis based on the updated soil and pheratic parameters determined.

It should be noted that if operations at the Buck Steam Station are modified and Basin 1 is dredged resulting in the new dike impounding liquid it is recommended that a rapid drawdown analyses be performed.

4.14 Additional Stability Analyses – Main Dike

The steady state analysis in 1996 for the main dike (adjacent to Basin 2) indicated a factor of safety of 1.4 for the downstream slope, which is below the recommended criteria of 1.5. Additional piezometers were installed after the fourth independent inspection report to verify uplift conditions at depth in the main dike. An independent review of recent piezometers readings should be conducted to confirm that uplift conditions at depth are below hydrostatic.

4.15 Additional Stability Analyses – Diverter Dike

If operations at the Buck Steam Station are modified and Basin 2 is dredged resulting in the diverter dike impounding liquid it is recommended that a steady state and rapid drawdown and analyses be performed.

4.16 Settlement Monitoring Points

The Buck Steam Station staff should continue to take settlement monitoring point readings on a regular annual basis. The readings should be plotted with previous readings to determine if the rate of settlement has changed.

4.17 Basin 3 Outlet Spillway Channel

CHA observed undermining and joint separation in the concrete-lined spillway channel conveying water below the downstream Main Dike toe to the Yadkin River. This does not appear to be an imminent threat to dike stability at this time, and given the fact that this area has been noted in previous inspections as a point of concern, is likely to have been a fairly slow developing condition over a period of years. If left unchecked however, the rate of undermining can increase and can reach the point where the spillway no longer protects the downstream toe from continual erosion as more sections drop away from the channel. The presence of the Yadkin River backwater in this area of the dike exacerbates the problem by softening the soils, especially during periods of higher water levels. As a consequence, CHA recommends careful routine inspection, particularly after the area experiences periods of heavy rainfall and plant sump pumping, high river levels, or increased power generation that leads to higher CCW sluicing volumes. Should a marked increase in undermining and resulting spillway joint separation or lining displacement become evident, the outlet spillway channel should be repaired or replaced.

5.0 CLOSING

The information presented in this report is based on visual field observations, review of reports by others and this limited knowledge of the history of the Buck Steam Plant surface impoundments. The recommendations presented are based, in part, on project information available at the time of this report. No other warranty, expressed or implied is made. Should additional information or changes in field conditions occur, the conclusions and recommendations provided in this report should be re-evaluated by an experienced engineer.

APPENDIX A

Completed EPA Coal Combustion Dam Inspection Checklist Forms

&

Completed EPA Coal Combustion Waste (CCW) Impoundment Inspection Forms

Coal Combustion Dam Inspection Checklist Form

US Environmental
Protection Agency

Site Name:	Buck Steam Plant	Date:	June 9, 2009
Unit Name:	Additional Primary Cell Basin	Operator's Name:	Duke Energy
Unit I.D.:	Basin #1	Hazard Potential Classification:	High Significant Low
Inspector's Name:	Katherine Adnams/Malcolm D. Hargraves		

Check the appropriate box below. Provide comments when appropriate. If not applicable or not available, record "N/A". Any unusual conditions or construction practices that should be noted in the comments section. For large diked embankments, separate checklists may be used for different embankment areas. If separate forms are used, identify approximate area that the form applies to in comments.

	Yes	No		Yes	No
1. Frequency of Company's Dam Inspections?	monthly		18. Sloughing or bulging on slopes?		x
2. Pool elevation (operator records)?	703		19. Major erosion or slope deterioration?		x
3. Decant inlet elevation (operator records)?	703		20. Decant Pipes:		
4. Open channel spillway elevation (operator records)?	n/a		Is water entering inlet, but not exiting outlet?		x
5. Lowest dam crest elevation (operator records)?	710		Is water exiting outlet, but not entering inlet?		x
6. If instrumentation is present, are readings recorded (operator records)?	x		Is water exiting outlet flowing clear?		x
7. Is the embankment currently under construction?		x	21. Seepage (specify location, if seepage carries fines, and approximate seepage rate below):		
8. Foundation preparation (remove vegetation,stumps, topsoil in area where embankment fill will be placed)?	n/a		From underdrain?	x	
9. Trees growing on embankment? (If so, indicate largest diameter below)		x	At isolated points on embankment slopes?		x
10. Cracks or scarps on crest?		x	At natural hillside in the embankment area?		x
11. Is there significant settlement along the crest?		x	Over widespread areas?		x
12. Are decant trashracks clear and in place?	x		From downstream foundation area?		x
13. Depressions or sinkholes in tailings surface or whirlpool in the pool area?		x	"Boils" beneath stream or ponded water?		x
14. Clogged spillways, groin or diversion ditches?		x	Around the outside of the decant pipe?	x	
15. Are spillway or ditch linings deteriorated?		x	22. Surface movements in valley bottom or on hillside?		x
16. Are outlets of decant or underdrains blocked?		x	23. Water against downstream toe?		x
17. Cracks or scarps on slopes?		x	24. Were Photos taken during the dam inspection?	x	

Major adverse changes in these items could cause instability and should be reported for further evaluation. Adverse conditions noted in these items should normally be described (extent, location, volume, etc.) in the space below and on the back of this sheet.

Inspection Issue #	Comments
1	Duke Energy makes monthly and annual inspections of the dam along with piezometric measurements.
12	Floating log skimmer functions as trashrack.
15,16	The spillway has stop logs and functions as a decanting device; the entrance to outlet pipe is submerged.
20	Spillway/decanting structure conveys partially decanted water to secondary basin to finish decanting.
21	Seepage noted at toe adjacent to toe drain was generally clear, not turbid; drain appears to be functioning.
	Clear seepage was also noted along outside of outlet pipe and is designated as an item to routinely monitor.

U. S. Environmental Protection Agency

Coal Combustion Waste (CCW)
Impoundment Inspection

Impoundment NPDES Permit # NC0004774 INSPECTOR Adnams/Hargraves
Date June 9, 2009

Impoundment Name Additional Primary Cell Basin (Basin #1)
Impoundment Company Duke Energy Carolinas, LLC
EPA Region 4
State Agency (Field Office) Addresss NC Dept. of Environment and Natural Resources
2090 US Highway 70, Swannanoa, NC 28778
Name of Impoundment Additional Primary Cell Basin (Basin #1)
(Report each impoundment on a separate form under the same Impoundment NPDES Permit number)

New ________ Update x

	Yes	No
Is impoundment currently under construction?		x
Is water or ccw currently being pumped into the impoundment?	x	

IMPOUNDMENT FUNCTION: Fly Ash, Bottom Ash, Boiler Slag, Stormwater, Plant Runoff

Nearest Downstream Town : Name High Rock, North Carolina
Distance from the impoundment roughly 15 river miles
Impoundment
Location: Longitude 80 Degrees 22 Minutes 21.51 Seconds
Latitude 35 Degrees 42 Minutes 15.54 Seconds
State NC County Rowan

Does a state agency regulate this impoundment? YES x NO ______

If So Which State Agency? North Carolina Utilities Commission

<u>HAZARD POTENTIAL</u> (In the event the impoundment should fail, the following would occur):

______ **LESS THAN LOW HAZARD POTENTIAL:** Failure or misoperation of the dam results in no probable loss of human life or economic or environmental losses.

______ **LOW HAZARD POTENTIAL:** Dams assigned the low hazard potential classification are those where failure or misoperation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the owner's property.

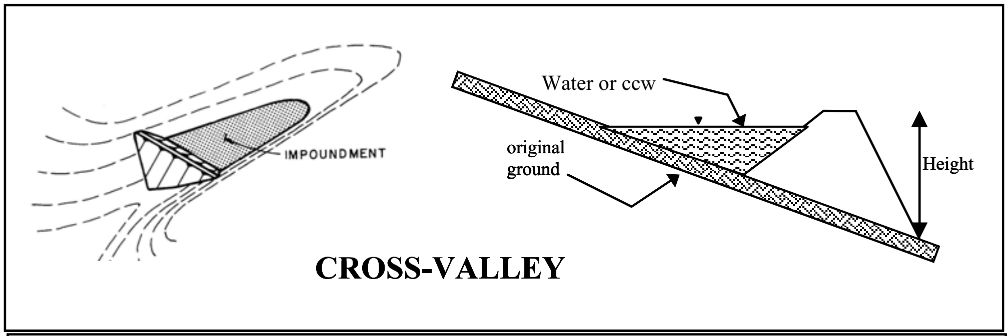
x______ **SIGNIFICANT HAZARD POTENTIAL:** Dams assigned the significant hazard potential classification are those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.

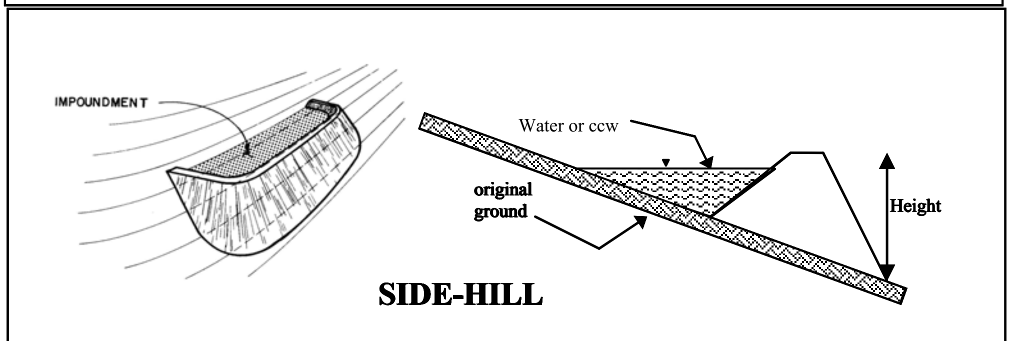
______ **HIGH HAZARD POTENTIAL:** Dams assigned the high hazard potential classification are those where failure or misoperation will probably cause loss of human life.

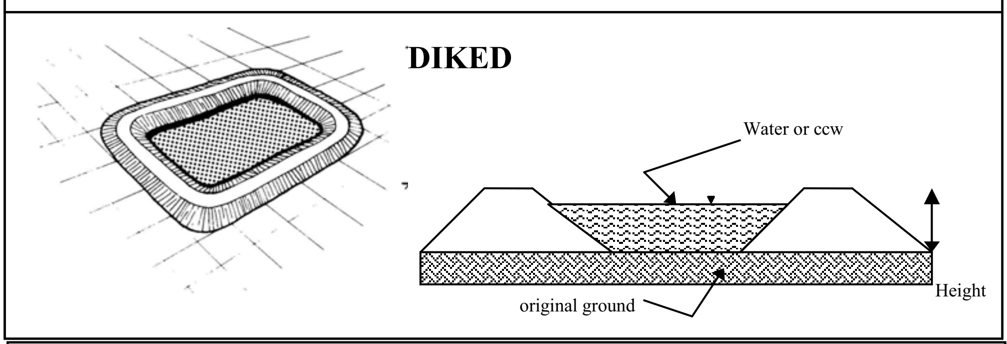
DESCRIBE REASONING FOR HAZARD RATING CHOSEN:

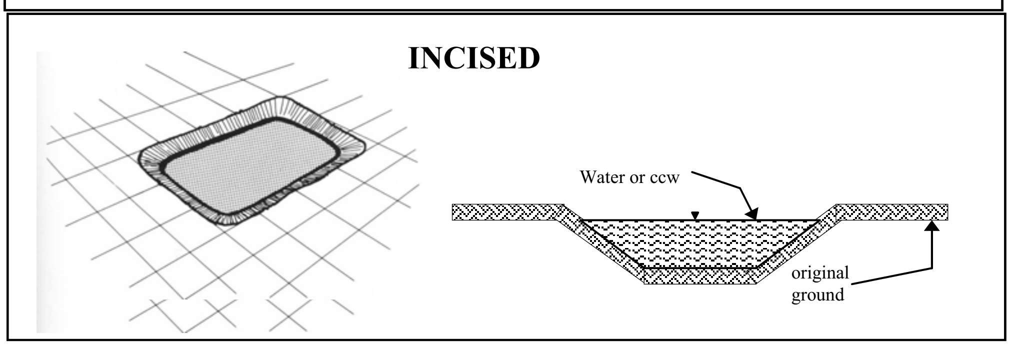
An uncontrolled release of CCW from this impoundment would impact traffic on the access drive to the plant, the combined cycle facility currently under construction, a backwater channel of the Yadkin River, and the existing facility. Environmental impacts to the river and aquatic life is probable and loss of life to plant personnel working in or driving to the facility is likely if this were to occur.

CONFIGURATION:









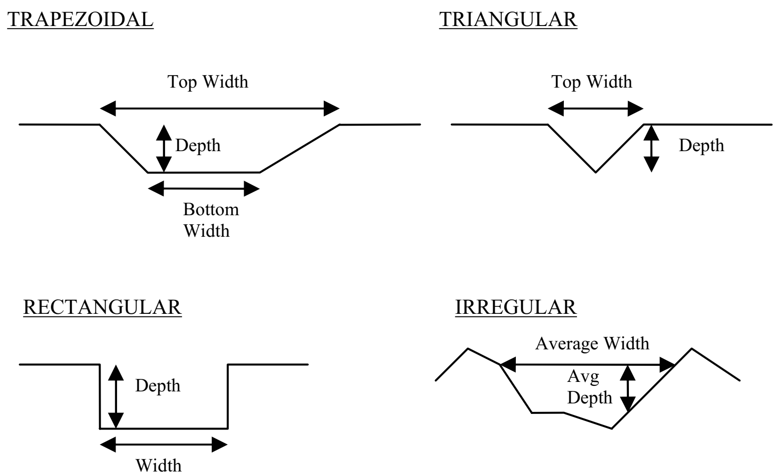
x_____ Cross-Valley
______ Side-Hill
______ Diked
______ Incised (form completion optional)
______ Combination Incised/Diked

Embankment Height 72 feet   Embankment Material Native Borrow
Pool Area 73.5 acres   Liner none
Current Freeboard 7 feet   Liner Permeability n/a

TYPE OF OUTLET (Mark all that apply)

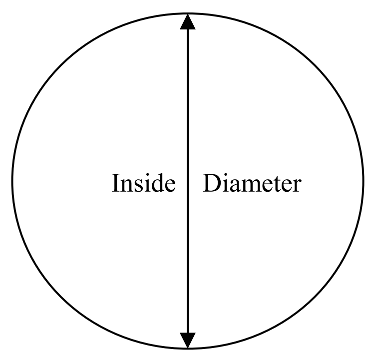
n/a ___ **Open Channel Spillway**
______ Trapezoidal
______ Triangular
______ Rectangular
______ Irregular

______ depth
______ bottom (or average) width
______ top width



yes ___ **Outlet**

36 ___ inside diameter



Material
______ corrugated metal
______ welded steel
x _____ concrete
______ plastic (hdpe, pvc, etc.)
______ other (specify) ______________________

Is water flowing through the outlet? YES x ______ NO _______

n/a ___ **No Outlet**

______ **Other Type of Outlet** (specify) ________________________________

The Impoundment was Designed By Duke Power Company Company

Has there ever been a failure at this site? YES __________ NO x__________

If So When? ____________________________

If So Please Describe :

Has there ever been significant seepages at this site?   YES _______ NO x_______

If So When? ___________________________

IF So Please Describe:

Has there ever been any measures undertaken to monitor/lower
Phreatic water table levels based on past seepages or breaches
at this site? YES ________ NO x________

If so, which method (e.g., piezometers, gw pumping,...)? see below

If so Please Describe :

There have been monitoring wells/piezometers installed at different times as a part of a monitoring and maintenance program. Water level measurements have been and continue to be recorded periodically at these locations.

Coal Combustion Dam Inspection Checklist Form

US Environmental Protection Agency

Site Name: Buck Steam Plant	Date: June 10, 2009
Unit Name: Old Primary Cell	Operator's Name: Duke Energy
Unit I.D.: Basin #2	Hazard Potential Classification: High Significant Low
Inspector's Name: Katherine Adnams/Malcolm D. Hargraves	

Check the appropriate box below. Provide comments when appropriate. If not applicable or not available, record "N/A". Any unusual conditions or construction practices that should be noted in the comments section. For large diked embankments, separate checklists may be used for different embankment areas. If separate forms are used, identify approximate area that the form applies to in comments.

	Yes	No		Yes	No
1. Frequency of Company's Dam Inspections?	monthly		18. Sloughing or bulging on slopes?		x
2. Pool elevation (operator records)?	686		19. Major erosion or slope deterioration?		x
3. Decant inlet elevation (operator records)?	686		20. Decant Pipes:		
4. Open channel spillway elevation (operator records)?	n/a		Is water entering inlet, but not exiting outlet?		x
5. Lowest dam crest elevation (operator records)?	690		Is water exiting outlet, but not entering inlet?		x
6. If instrumentation is present, are readings recorded (operator records)?	x		Is water exiting outlet flowing clear?		x
7. Is the embankment currently under construction?		x	21. Seepage (specify location, if seepage carries fines, and approximate seepage rate below):		
8. Foundation preparation (remove vegetation,stumps, topsoil in area where embankment fill will be placed)?	n/a		From underdrain?		x
9. Trees growing on embankment? (If so, indicate largest diameter below)		x	At isolated points on embankment slopes?		x
10. Cracks or scarps on crest?		x	At natural hillside in the embankment area?		x
11. Is there significant settlement along the crest?		x	Over widespread areas?		x
12. Are decant trashracks clear and in place?		x	From downstream foundation area?	x	
13. Depressions or sinkholes in tailings surface or whirlpool in the pool area?		x	"Boils" beneath stream or ponded water?		x
14. Clogged spillways, groin or diversion ditches?	x		Around the outside of the decant pipe?		x
15. Are spillway or ditch linings deteriorated?		x	22. Surface movements in valley bottom or on hillside?		x
16. Are outlets of decant or underdrains blocked?		x	23. Water against downstream toe?	x	
17. Cracks or scarps on slopes?		x	24. Were Photos taken during the dam inspection?	x	

Major adverse changes in these items could cause instability and should be reported for further evaluation. Adverse conditions noted in these items should normally be described (extent, location, volume, etc.) in the space below and on the back of this sheet.

Inspection Issue #	Comments
1	Duke Energy makes monthly and annual inspections and takes periodic piezometric measurements
12,14,15,16	A floating log skimmer functions as trashrack at the top of the spillway. The spillway and stoplogs have become silted-in, vegetated, and partially obstructed while functioning as an additional decanting device between the old primary basin and secondary basin; the entrance and exit to the outlet pipe is submerged.
20	Spillway/decanting structure conveys partially decanted water to secondary basin.
21,23	Area above rip-rap toe (0.4" rain night before) may be seep. Yadkin River and Basin #3 at dike toes.

U. S. Environmental Protection Agency

Coal Combustion Waste (CCW)
Impoundment Inspection

Impoundment NPDES Permit # NC0004774 INSPECTOR Adnams/Hargraves

Date June 10, 2009

Impoundment Name Old Primary Cell Basin (Basin #2)

Impoundment Company Duke Energy Carolinas, LLC

EPA Region 4

State Agency (Field Office) Addresss NC Dept. of Environment and Natural Resources
2090 US Highway 70, Swannanoa, NC 28778

Name of Impoundment Old Primary Cell Basin (Basin #2)

(Report each impoundment on a separate form under the same Impoundment NPDES Permit number)

New ________ Update x

	Yes	No
Is impoundment currently under construction?		x
Is water or ccw currently being pumped into the impoundment?	x	

IMPOUNDMENT FUNCTION: Fly Ash, Bottom Ash, Boiler Slag, Stormwater, Plant Runoff

Nearest Downstream Town : Name High Rock, North Carolina

Distance from the impoundment roughly 15 river miles

Impoundment Location:

Longitude	80	Degrees	21	Minutes	59.07	Seconds
Latitude	35	Degrees	42	Minutes	19.36	Seconds
State	NC	County	Rowan			

Does a state agency regulate this impoundment? YES x NO ______

If So Which State Agency? North Carolina Utilities Commission

HAZARD POTENTIAL (In the event the impoundment should fail, the following would occur):

______ **LESS THAN LOW HAZARD POTENTIAL:** Failure or misoperation of the dam results in no probable loss of human life or economic or environmental losses.

______ **LOW HAZARD POTENTIAL:** Dams assigned the low hazard potential classification are those where failure or misoperation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the owner's property.

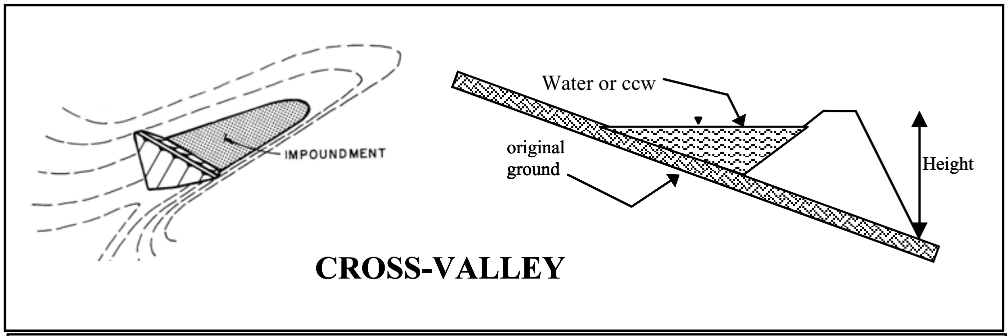
x______ **SIGNIFICANT HAZARD POTENTIAL:** Dams assigned the significant hazard potential classification are those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.

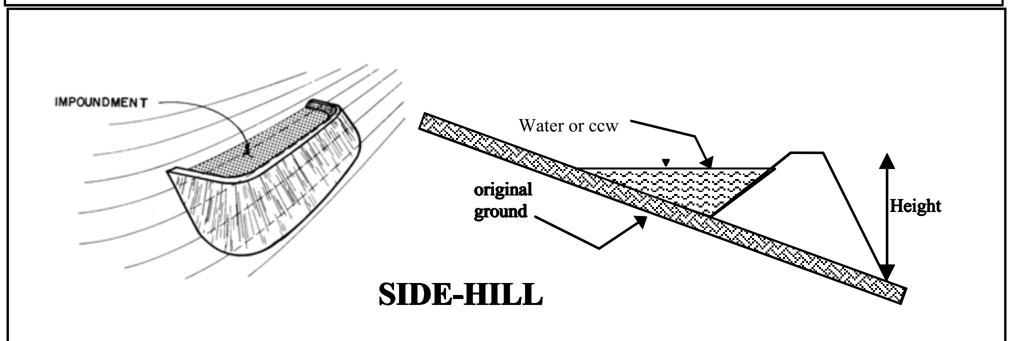
______ **HIGH HAZARD POTENTIAL:** Dams assigned the high hazard potential classification are those where failure or misoperation will probably cause loss of human life.

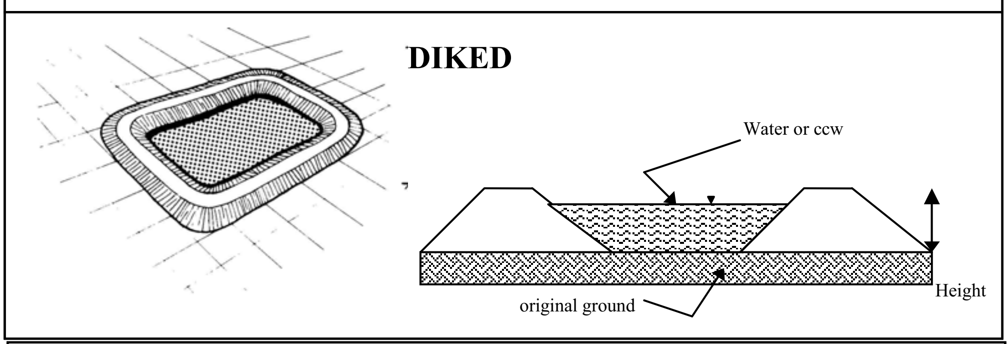
DESCRIBE REASONING FOR HAZARD RATING CHOSEN:

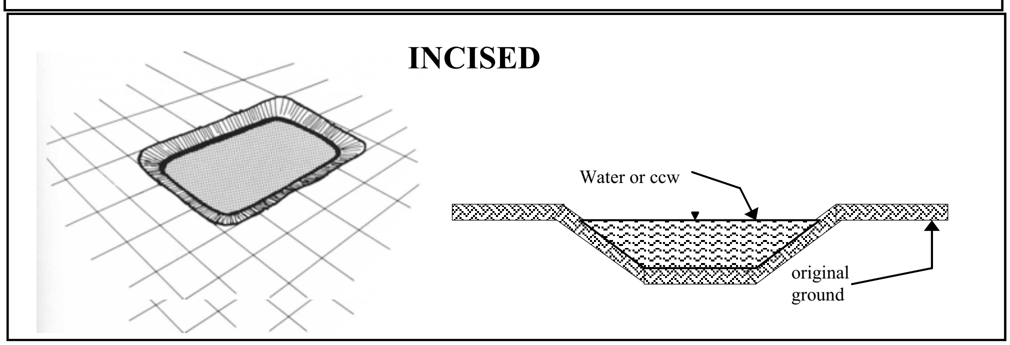
An uncontrolled release of CCW from this impoundment would impact a backwater channel of the Yadkin River. Environmental impacts to the river and aquatic life is probable. It should be noted that roughly one half of this basin is forested with heavy vegetation and trees, supports pedestrian and drilling equipment traffic and no longer has open water. Furthermore, the vegetated areas are immediately adjacent to the dikes that formed the basin, such that the dikes no longer retain free water. With this understanding, though a "significant" hazard rating has been given, the conditions that could initiate a failure or release have been reduced, lowering the likelihood of failure.

CONFIGURATION:









x_____ Cross-Valley
______ Side-Hill
______ Diked
______ Incised (form completion optional)
______ Combination Incised/Diked

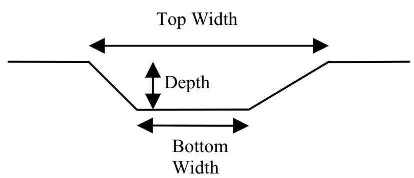
Embankment Height 70, 15 feet Embankment Material Native Borrow
Pool Area 46 - about half is wooded acres Liner none
Current Freeboard 4 feet Liner Permeability n/a

<u>TYPE OF OUTLET</u> (Mark all that apply)

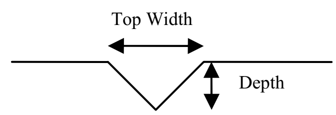
n/a **Open Channel Spillway**
______ Trapezoidal
______ Triangular
______ Rectangular
______ Irregular

______ depth
______ bottom (or average) width
______ top width

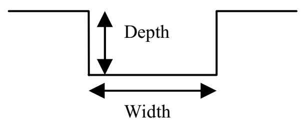
<u>TRAPEZOIDAL</u>



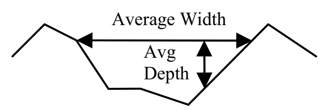
<u>TRIANGULAR</u>



<u>RECTANGULAR</u>

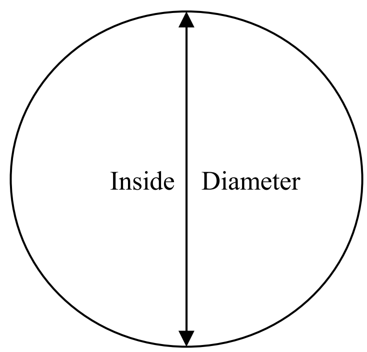


<u>IRREGULAR</u>



yes **Outlet**

42 inside diameter



Material
______ corrugated metal
______ welded steel
x concrete
______ plastic (hdpe, pvc, etc.)
______ other (specify) ______________________

Is water flowing through the outlet? YES x______ NO ________

n/a **No Outlet**

______ **Other Type of Outlet** (specify) ________________________________

The Impoundment was Designed By Duke Power Company Company

Has there ever been a failure at this site? YES __________ NO x__________

If So When? ___________________________

If So Please Describe :

Has there ever been significant seepages at this site? YES x NO ______

If So When? 1977, 1979

IF So Please Describe:

A divider dike connected to the main dike and splitting the original basin into what is now known as the Old Primary Cell Basin (Basin #2) and the Secondary Cell Basin (Basin #3) was constructed in 1977 to increase the pool elevation and ash capacity of Basin #2. After this construction, as water and ash was impounded behind the divider dike, boils were observed in the Basin #3 pool beyond the toe of the divider dike, near the intersection of the divider dike and the main dike. Additional soil and rip rap was placed in this area to repair the boils through the ash foundation material at that time and the plant operator limited to an active pool elevation difference between the old primary basin and secondary basin to approximately 10 feet. Since that time, the old primary basin was taken out of active service circa 1982 after what is now known as the Additional Primary Cell Basin (Basin #3) was constructed and placed in operation. As mentioned previously, the dikes no longer retain open water in Basin #2 due to the vegetated cover on the basin surface.

Has there ever been any measures undertaken to monitor/lower Phreatic water table levels based on past seepages or breaches at this site? YES ________ NO x________

If so, which method (e.g., piezometers, gw pumping,...)? see below

If so Please Describe :

There have been monitoring wells/piezometers installed at different times as a part of a monitoring and maintenance program. Water level measurements have been and continue to be recorded periodically at these locations. As mentioned previously, a limit on the pool elevation difference between Basin #2 and Basin #3 was placed in response to the 1977 and 1979 boils. The wooded condition of the present basin serves to further mitigate seepage problems related to an elevation head differential.

Coal Combustion Dam Inspection Checklist Form

US Environmental Protection Agency

Site Name:	Buck Steam Plant	**Date:**	June 10, 2009
Unit Name:	Old Primary Cell	**Operator's Name:**	Duke Energy
Unit I.D.:	Basin #3	**Hazard Potential Classification:**	High Significant Low
Inspector's Name:	Katherine Adnams/Malcolm D. Hargraves		

Check the appropriate box below. Provide comments when appropriate. If not applicable or not available, record "N/A". Any unusual conditions or construction practices that should be noted in the comments section. For large diked embankments, separate checklists may be used for different embankment areas. If separate forms are used, identify approximate area that the form applies to in comments.

	Yes	No		Yes	No
1. Frequency of Company's Dam Inspections?	monthly		18. Sloughing or bulging on slopes?		x
2. Pool elevation (operator records)?	675		19. Major erosion or slope deterioration?		x
3. Decant inlet elevation (operator records)?	675		20. Decant Pipes:		
4. Open channel spillway elevation (operator records)?	n/a		Is water entering inlet, but not exiting outlet?		x
5. Lowest dam crest elevation (operator records)?	680		Is water exiting outlet, but not entering inlet?		x
6. If instrumentation is present, are readings recorded (operator records)?	x		Is water exiting outlet flowing clear?	x	
7. Is the embankment currently under construction?		x	21. Seepage (specify location, if seepage carries fines, and approximate seepage rate below):		
8. Foundation preparation (remove vegetation,stumps, topsoil in area where embankment fill will be placed)?	n/a		From underdrain?		x
9. Trees growing on embankment? (If so, indicate largest diameter below)		x	At isolated points on embankment slopes?		x
10. Cracks or scarps on crest?		x	At natural hillside in the embankment area?		x
11. Is there significant settlement along the crest?		x	Over widespread areas?		x
12. Are decant trashracks clear and in place?	x		From downstream foundation area?	x	
13. Depressions or sinkholes in tailings surface or whirlpool in the pool area?		x	"Boils" beneath stream or ponded water?		x
14. Clogged spillways, groin or diversion ditches?		x	Around the outside of the decant pipe?		x
15. Are spillway or ditch linings deteriorated?	x		22. Surface movements in valley bottom or on hillside?		x
16. Are outlets of decant or underdrains blocked?		x	23. Water against downstream toe?	x	
17. Cracks or scarps on slopes?		x	24. Were Photos taken during the dam inspection?	x	

Major adverse changes in these items could cause instability and should be reported for further evaluation. Adverse conditions noted in these items should normally be described (extent, location, volume, etc.) in the space below and on the back of this sheet.

Inspection Issue #	Comments
1	Duke Energy makes monthly and annual inspections and takes periodic piezometric measurements
12	A floating deck skimmer also functions as trashrack at the top of the spillway.
15	Ditch lining downstream of outlet has separated joints and is displaced at river edge. Noted as point of emphasis on routine inspections; entrance to outlet pipe is submerged.
21,23	Wet area above rip-rap toe (0.4" rain night before) may be seep. Yadkin River backwater at base of rip rap toe.

U. S. Environmental Protection Agency

Coal Combustion Waste (CCW)
Impoundment Inspection

Impoundment NPDES Permit # NC0004774 INSPECTOR Adnams/Hargraves

Date June 10, 2009

Impoundment Name Secondary Cell Basin (Basin #3)

Impoundment Company Duke Energy Carolinas, LLC

EPA Region 4

State Agency (Field Office) Addresss NC Dept. of Environment and Natural Resources
2090 US Highway 70, Swannanoa, NC 28778

Name of Impoundment Secondary Cell Basin (Basin #3)

(Report each impoundment on a separate form under the same Impoundment NPDES Permit number)

New ________ Update x

	Yes	No
Is impoundment currently under construction?		x
Is water or ccw currently being pumped into the impoundment?	x	

IMPOUNDMENT FUNCTION: Fly Ash, Bottom Ash, Boiler Slag, Stormwater, Plant Runoff

Nearest Downstream Town : Name High Rock, North Carolina

Distance from the impoundment roughly 15 river miles

Impoundment

Location: Longitude 80 Degrees 21 Minutes 45.85 Seconds

Latitude 35 Degrees 42 Minutes 35.36 Seconds

State NC County Rowan

Does a state agency regulate this impoundment? YES x NO ______

If So Which State Agency? North Carolina Utilities Commission

<u>HAZARD POTENTIAL</u> (In the event the impoundment should fail, the following would occur):

______ **LESS THAN LOW HAZARD POTENTIAL:** Failure or misoperation of the dam results in no probable loss of human life or economic or environmental losses.

______ **LOW HAZARD POTENTIAL:** Dams assigned the low hazard potential classification are those where failure or misoperation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the owner's property.

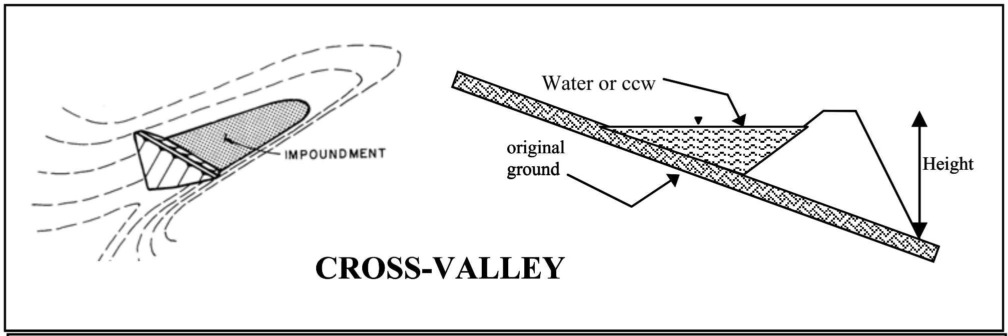
x______ **SIGNIFICANT HAZARD POTENTIAL:** Dams assigned the significant hazard potential classification are those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.

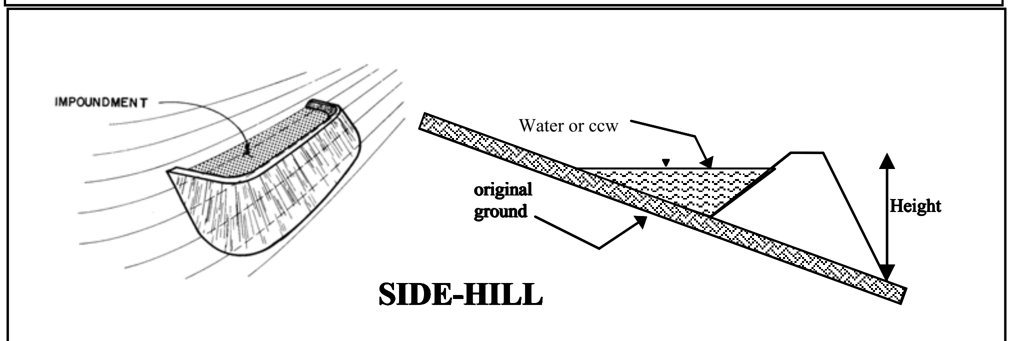
______ **HIGH HAZARD POTENTIAL:** Dams assigned the high hazard potential classification are those where failure or misoperation will probably cause loss of human life.

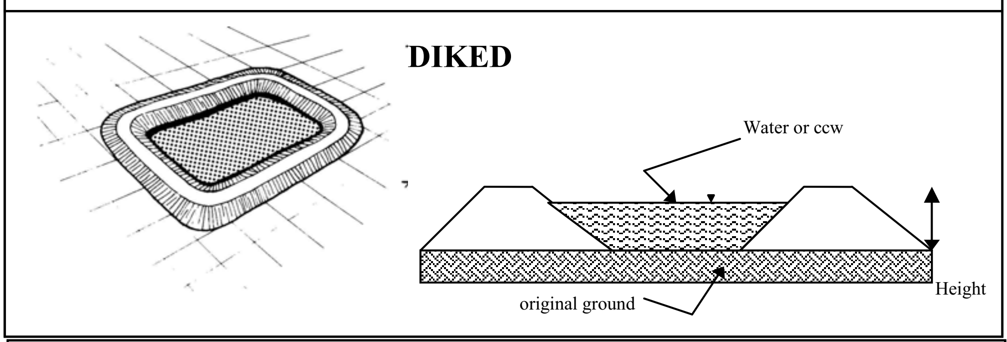
DESCRIBE REASONING FOR HAZARD RATING CHOSEN:

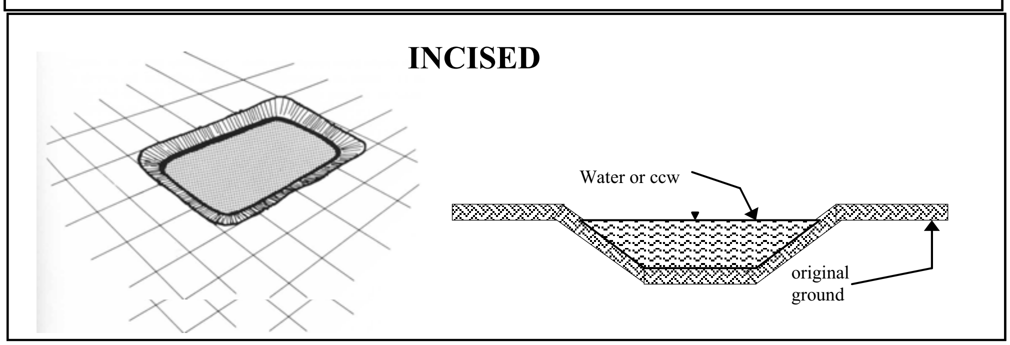
An uncontrolled release of CCW from this impoundment would impact a backwater channel of the Yadkin River. Environmental impacts to the river and aquatic life is probable.

CONFIGURATION:









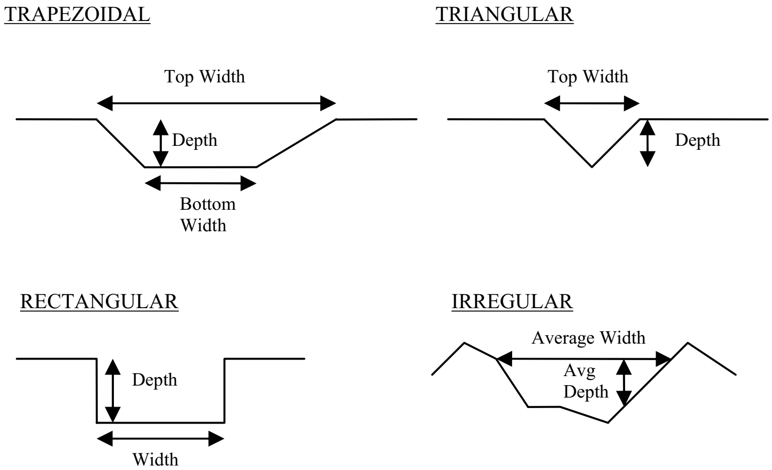
x_____ Cross-Valley
______ Side-Hill
______ Diked
______ Incised (form completion optional)
______ Combination Incised/Diked

Embankment Height 70 feet   Embankment Material Native Borrow
Pool Area 14.5 acres   Liner none
Current Freeboard 5 feet   Liner Permeability n/a

TYPE OF OUTLET (Mark all that apply)

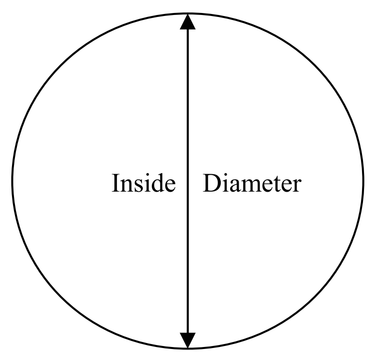
n/a **Open Channel Spillway**
______ Trapezoidal
______ Triangular
______ Rectangular
______ Irregular

______ depth
______ bottom (or average) width
______ top width



yes **Outlet**

36 inside diameter



Material
x corrugated metal
______ welded steel
______ concrete
______ plastic (hdpe, pvc, etc.)
______ other (specify) ______________________

Is water flowing through the outlet? YES x______ NO ________

n/a **No Outlet**

______ **Other Type of Outlet** (specify) ____________________________________

The Impoundment was Designed By Duke Power Company Company
____

Has there ever been a failure at this site? YES __________ NO x__________

If So When? ___________________________

If So Please Describe :

Has there ever been significant seepages at this site?   YES _______ NO x_______

If So When? ___________________________

IF So Please Describe:

Has there ever been any measures undertaken to monitor/lower Phreatic water table levels based on past seepages or breaches at this site? YES ________ NO x________

If so, which method (e.g., piezometers, gw pumping,...)? see below

If so Please Describe :

There have been monitoring wells/piezometers installed at different times as a part of a monitoring and maintenance program. Water level measurements have been and continue to be recorded periodically at these locations.